THE INTERNATIONAL

TEXT-BOOK OF SURGERY

BY

AMERICAN AND BRITISH AUTHORS

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REGIONAL SURGERY.

CHAPTER I.

SURGERY OF THE MOUTH AND TONGUE.

CONGENITAL DEFORMITY OF THE LIPS AND MOUTH.

A PROPER understanding of the congenital deformities of the mouth and lips requires a knowledge of the various phases of development which these parts go through in early fetal life. The common buccal and nasal cavity is formed by the growth of the mandibular arches from either side, from which are developed the lower jaw, and the tissues which enter into the lower lip and the floor of the mouth. The common cavity is then divided into buccal and nasal cavities by the development of the hard palate from the horizontal outgrowth of plates from the maxillary process (Fig. 1).
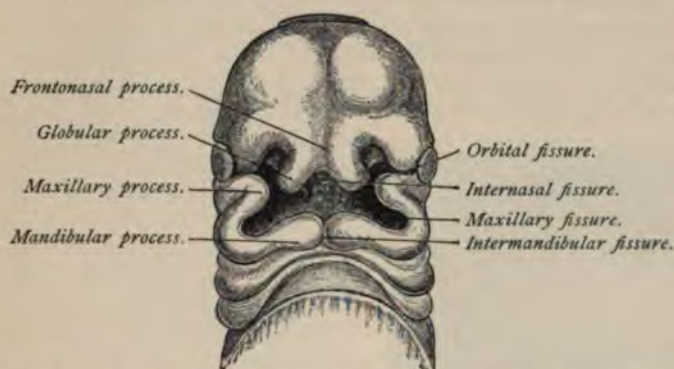
FIG. 1.—Head of an embryo, showing the disposition of the facial fissures (semi-diagrammatic) (Sutton).

The nasal cavity further is divided into two by the down-growth of the perpendicular plate of the ethmoid and vomer from the frontonasal processes. A failure of union between these different parts explains the occurrence of the various kinds and degrees of deformity in harelip and cleft palate. The researches of Albrecht have very fully established the essential facts of development.

"From the buccal aspect of the maxillary process of either side springs the palatal process which passes inward to blend with its fellow of the opposite side to form the soft palate and the whole of the hard palate except the intermaxillary portion." From the same source are derived the cheek, the lateral parts of the upper lip, and the upper maxillary bone. The frontonasal process gives origin to the external nose, the ethmoid, the vomer, the median portion of the upper lip, and the intermaxillary bone (Treves).

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The intermaxillary bone is that triangular piece which is attached to the vomer and forms so conspicuous a deformity in complete double harelip with cleft palate, and which in the normal jaw forms the anterior central portion of the upper jaw, in which the 4 incisors are inserted. It is, according to Albrecht, composed of 4 sections, named by him gnathia, each of which carries an incisor tooth. The median segment is known as the endognathion, the outer the mesognathion, while the hard palate beyond is the exognathion. The 5 sutures formed by the apposition of these 4 segments with the wedge-shape gap in the hard palate converge to the anterior palatine canal.

FIG. 2.—Endognathion, mesognathion, and exognathion with the sutures; inter-endognathic, endomesognathic, exomesognathic (Albrecht).

In the ordinary form of cleft palate the union of the two mesognathia forms the os incisivum which carries the two central incisors, and the cleft in the alveolar process runs between the endognathion and mesognathion. The latter carries the lateral incisor.

It is apparent from the facts thus set forth that the central part of the upper lip and that part of the hard palate which carries the two central incisors are developed from different centers from those forming the outer part of the upper lip and the rest of the hard palate, and that union in the lip and alveolar process takes place not in the median line, but to either side of it. It also satisfactorily explains the clinical fact that harelip does not occur in the median line, and that in complete cleft palate the intermaxillary bone is either without any connection with the hard palate or is connected only on one side.

In the lower lip the mandibular processes unite in the median line.

Varieties of Deformity.— Harelip and cleft palate may be divided into 6 classes, according to Rose.

" 1. The median (inter-intermaxillary). This is so rarely met with that its occurrence has been denied; it comes from failure of the endognathion. Most frequently it involves only the lip; more rarely there is entire absence of the intermaxillary bone and complete cleft of the palate, hard and soft.

FIG. 3.—Harelip and facial cleft.

" 2. Ordinary harelip (intermaxillary), either unilateral or bilateral, is the usual form. Here there has been a failure of union between the central and outer portions of the upper lip.

" 3. Facial cleft (intermaxillary). The cleft arises from the outer part of the upper lip, skirts around the ala of the nose, and reaches

FIG. 4.—Auricular appendage occasionally accompanying macrostoma.

the canthus of the eye. It usually involves only the soft parts, and not the bone (Fig. 3).

" 4. Buccal cleft (maxillomandibular), or macrostoma. In this deformity there has been a failure of union of that portion of the cheek developed from the maxillary process, and that from the mandibular arch (Fig. 4).

" 5. Mandibular cleft, or median fissure of the lower lip, is explained by the failure of the mandibular arch of either side to unite. It is very rare.

" 6. Cleft palate. The uvula alone may be involved, or the cleft may extend fully or partly through the hard palate. Union takes place normally from before backward, so that incomplete clefts always involve the posterior portion of the hard palate."

Microstoma is a condition due to undue fusion of the maxillary and mandibular processes. The opening of the mouth may be contracted to a small orifice.

Deformities of the mouth and lips may be caused by *contraction of cicatricial tissue*. The mouth

FIG. 5.—Closure of mouth from congenital syphilis.

may be nearly closed in this way (stenosis) (Fig. 5), or the lower lip may be everted, producing an incontinence of saliva. The plastic oper-

FIG. 6.—Characteristic deformity from burn.

ation for relief of this condition consists in turning in a flap of sound skin into the raw surface exposed by releasing the everted lip, or by

FIG. 7.—Drawn from specimen from a child two years old who died after the operation for harelip. Cleft palate and harelip. The vomer is attached to the right side of the palate and extends to the back of the pharynx.

FIG. 8,—Complete cleft palate. Vomer not attached to either side of hard palate (drawn from specimen).

sliding in flaps on either side from the cheek.   The operation is known as *cheiloplasty* (Fig. 6).

Treatment of Harelip and Cleft Palate.—When in cleft pal-

FIG. 9.—Harelip and cleft palate, showing protruding intermaxillary bone attached to the vomer.

ate the cleft is complete, the deformity involves the lip as well, and there is a double harelip, with the os incisivum attached to the end of the vomer and carrying the central portion of the lip.   Or there may

FIG. 10.—Cleft palate and harelip.   Marked deformity from intermaxillary bone, which was attached to the right side.

FIG. 11.—Patient represented in Fig. 10, two years after operation, showing notch in the upper lip.

be a single harelip, usually on the left side, with the intermaxillary bone attached to the right, and more or less projecting in front, so as to create a very disfiguring deformity.   The vomer is usually attached to the right side of the hard palate, though it may hang entirely free,

and may extend to the back of the pharynx, dividing that cavity into two. In cases of harelip with cleft palate in children who have reached five or six years of age, there is not infrequently associated adenoid vegetations, hypertrophy of the tonsils, and great thickening of the mucous membrane over the turbinated bones.

These conditions when present should always be corrected before any attempt is made to operate on the palate or lip. In all cases where the defect reaches through the entire lip, whether associated with cleft palate or not, the nostril upon the same side is widened and flattened so as to be very unsightly, and this is likely to be increased, as time goes on, by the action of the orbicularis.

In harelip, either single or double, approximation of the edges of the gap is usually opposed by reflections of mucous membrane which are attached to the upper jaw, so as to prevent the separated portions of the lip being brought together. In double harelip the central philtrum of skin is usually closely bound to the underlying bone, and but partly covers it. This is especially the case when we have an isolated os incisivum in complete cleft palate. Children with cleft palate who have begun to talk have a disagreeable nasal twang, and this usually persists, though possibly improved, even after a successful operation or the adjustment of an obturator.

Immediately after birth it may be extremely difficult for the child to take sufficient nourishment; the nipple cannot be grasped, and sucking is impossible, and the child must be fed with a spoon. Various shields have been suggested, but none of them are satisfactory.

Age for Operation.—It is desirable that the defect in both harelip and cleft palate should be corrected at as early an age as possible; the beneficial result, so far as phonation is concerned, depends largely upon this, and some surgeons therefore advocate operation on harelip within a few days of birth. Such early operations are, however, attended with so great a mortality that the majority advise waiting for the completion of the third month. Operation at this time is indicated in all cases of harelip, whether complicated with cleft palate or not.

The closure of the cleft in the palate is so much more serious that by universal consent it is deferred until several years of life are past, certainly not sooner than the end of the third year. The early closure of the harelip usually exercises a beneficial effect upon the cleft, diminishing the prominence of the os incisivum and approximating the edges of the lateral processes. Too long a delay in operating diminishes the prospect of full improvement in articulation.

Operations for Harelip.—A variety of operations have been suggested for harelip, which are generally named after their authors. A glance at the diagram is enough to explain the general principles, without going into a detailed description. Certain points must be kept in view as essential to success (Figs. 12 and 13).

First, the lip on either side must be sufficiently freed from the cheek to ensure easy contact of the edges of the gap without tension. This freeing of the lip is the first step, and is best done with scissors curved on the flat. Success in the cosmetic effect depends upon the ala of the nose being well freed. In paring the edges of the gap in the lip care must be taken to see that the incision is well beyond the everted mu-

cous membrane. It is best made by transfixion with a narrow-bladed knife, entered just above the vermilion border and made to cut upward. In cutting through the vermilion border care must be taken that when placed in apposition with the opposite side a projection will be formed, otherwise a disfiguring notch will ultimately result. During this time

FIG. 12.—Nélaton's operation for harelip.

of the operation the child may be upon its back, with head well extended over a pillow, bleeding being controlled by the fingers of an assistant compressing the coronary artery. More or less blood will, however, often be swallowed, interrupting the operation.

If, instead of being placed upon its back, the child is turned over on

FIG. 13.—Mirault's operation for harelip.

its side and the head supported by a sand-bag, swallowing of blood will be largely prevented. Chloroform should, as a rule, be used, and all bleeding stopped before the stitches for closure are introduced. The edges of the gap should be brought into apposition and made to fit accurately. The first suture should be introduced through the vermilion border and made to come out on the opposite side. Traction on this suture will at once show whether the two sides of the wound come together accurately. The stitches are then introduced, commencing above at the highest point of the defect. They should not involve the mucous membrane. Three stitches are usually enough, and all should be introduced before any are tied. The one through the vermilion border should first be tied, and the others from above downward. Harelip-pins are unnecessary. Silkworm-gut is the best material for sutures; silk or silver wire may, however, be used. At the end of the suturing there should be accurate approximation throughout the incision, and a little nipple-like projection on the vermilion border. Two or three thicknesses of gauze extending well over the cheek may be laid over the wound and well saturated with collodion. This is better than adhesive straps, and prevents traction on the wound when the child is crying. If there is any gaping, one or two fine catgut stitches

may be placed through the mucous membrane. The stitches should be left in until about the seventh day, and the child fed with a spoon during this time.

Warren's method consists in applying the sutures so that they shall cause a minimum of deformity from stitch-scars. An "anchor suture" of silver wire is passed through the ala nasi, high up, and the septum. It is held in place by shot. Three or 4 ordinary silk sutures are passed from the mucous aspect of the lip through the deep tissues, coming near

FIG. 14.—Warren's operation for harelip, showing method of applying sutures.

the surface at the cut edges, but not showing outside (Fig. 14). When these sutures are tied, any little irregularities of adjustment can be remedied by a few very fine sutures (Fig. 15).

FIG. 15.—Warren's operation for harelip : sutures tied.

Operations for Cleft Palate.—*Uranoplasty and Staphylorrhaphy.*— The operation for cleft palate and uvula is much more difficult and

dangerous than that for harelip alone, and should not be undertaken before the completion of the third year. If the cleft is complicated with harelip, careful treatment should first be undertaken for the removal of adenoid vegetations, enlarged tonsils, and hypertrophied turbinated bones, provided they are present. These bodies are easily accessible, and may readily be subjected to proper treatment. In the operation we seek to complete the septum between the mouth and nasal cavities and to unite the uvula. Furthermore, we have to remove the unsightly deformity caused by the projecting os incisivum. Attempts to force this directly backward are seldom successful, and are likely to change the direction of the teeth in an unfortunate manner. Rose advises the removal of a triangular piece of the vomer, while many surgeons advocate the removal of the entire mass, trusting to the dentist to supply the deficiency by a plate in the future. When the os incisivum is attached to one side, it would usually be better to remove any misplaced teeth and close the harelip over it. The pressure thus exerted will in the course of time greatly modify the deformity. When the mass is only attached to the vomer, section of this bone, as suggested by Rose, may be tried.

The cleft in the palate is closed by the operation formulated by Langenbeck, in which a mucoperiosteal flap is raised from the hard palate on either side and displaced inward until it can be united to a similar flap from the opposite side.

In this operation light is of the utmost importance. Direct sunlight may be used, or the head mirror, or a movable electric light. There is always hemorrhage, which becomes annoying by the blood finding its way into the trachea, and so causing interference with the respiration and consequent struggling, which interrupts the anesthesia. This is best prevented by placing the patient on his side, or even somewhat prone, and having the head supported on a sand-bag. In this position the blood falls into the hollow of the cheek, and the operator works to better advantage.

The patient is thoroughly anesthetized, and the jaws are widely opened with a mouth-gag, the simpler the better; this is essential. The point of a strong knife is now entered opposite the last molar directly down to the bone, and carried forward parallel to the alveolar process, and the incision terminated a little beyond the anterior part of the cleft. The cut must be made down to the bone. A properly curved periosteal elevator is now used, and the entire covering of the bony palate is freed to the edge of the cleft. The attachment of the soft palate may be cut with scissors. The flap thus separated is still attached at both ends, so that there is no danger of sloughing. The bleeding is likely to be free, and should be controlled by sponge-pressure.

The opposite side is now treated in the same way. Hemorrhage having been controlled, the uvula is seized on one side with a pair of toothed forceps long enough to be held easily, and a narrow-bladed knife is made to penetrate it near the tip on the inner edge, cutting forward to the anterior end of the cleft in an unbroken line. A similar incision is now made on the other side. The amount of tissue removed should be as small as possible. The material used for uniting the edges of the flap may be silk, silkworm-gut, or silver; the last is prob-

ably the best. The introduction of the sutures and the exact approximation of the edges of the cleft are the difficult parts of the operation. Needles on fixed handles may be used, or fully curved needles in a holder, or a special needle may be employed by which the silk suture can be withdrawn from the side of the cleft after the flap has been penetrated from the buccal aspect. This last was the method employed by Langenbeck, for which he invented a special needle. The introduction of sutures may be well effected by a needle on a handle having an eye near the point. It is threaded with medium-sized silk, and pushed through from the buccal surface, ¼ inch from the edge of the cleft. The silk is seized with forceps from within the cleft and the needle withdrawn. A similar needle, only threaded with a double silk, is made to transfix the opposite side. The loop is caught and the needle again withdrawn. The single thread first introduced is now caught in the loop and pulled through the flap. This operation is repeated until a sufficient number have been introduced, and the sides of the cleft are now brought together to see if approximation can be effected without tension; if not, the flaps must be still further loosened. The uvula is now united with fine silk. The sutures in the uvula are first tied, and then those in the roof of the mouth. Accurate approximation must be secured.

Finally, in order to relieve all tension, a knife is to be introduced into the lateral cut on either side, and the levator palati cut through by pushing it directly backward. This should never be omitted, no matter how well the parts lie together.

The patient should be kept perfectly quiet with the head low, and only a little iced milk and soda water given by a spoon or feeder for several days, and no hard food for two weeks. The mouth should be cleaned from time to time with a boric-acid wash or gargle. The occurrence of vomiting may be fatal to the success of the operation. The operation above described is the one now most generally practised, and is to be recommended.

Brophy's Method.—Brophy has described (Park's "Surgery") a new method of closing cleft palate. The sides of the cleft are forced together, after being thoroughly pared, by means of a wire which has been made to penetrate the upper jaw from side to side. The approximation is effected by twisting the wire over a lead plate. The originator of this method claims that it can be performed in a child a month old with but little shock, and that the ultimate results are far better than by the older method. Its introduction is still so recent that its merits cannot yet be decided.

C. B. Porter's operation for cleft palate is as follows: The patient should be of sufficient age to have teeth to which an obturator or diaphragm can be attached. This consists of a vulcanite plate stretching horizontally across the roof of the mouth from one alveolar arch to the other, with a curved projection behind to protect the soft palate. This is necessary because in the act of deglutition the tongue is pushed up forcibly against the roof of the mouth, and tends thereby to tear out the stitches. This diaphragm is made by a dentist and adjusted to the teeth, so as to remain firm when in place.

The operation is done in the Rose position—that is, with the patient

supine and the head hanging over the end of the table. There is more hemorrhage in this position than in the upright one, but the absolute freedom from danger of blood in the larynx and trachea entirely offsets this, which can be readily overcome by pressure with sea-sponges. The incisions are those above described as Langenbeck's method.

The next step is the placing of the stitches. These are placed by a small curved needle in a needle-holder, carrying medium-sized silk soaked in Tr. benzoin co. to prevent the first knot from slipping. This is a procedure learned from the late J. Mason Warren, Surgeon Massachusetts General Hospital, who had an extensive reputation for the repair of cleft palate.

The stitches are placed about $\frac{1}{4}$ inch apart, $\frac{1}{4}$ inch from the edge of the flap, and all in position before any are tied. They are tied from behind forward, all left long until the last is tied, because if the adjustment of the edge is not complete at any point, traction on the two adjacent stitches makes the placing of another between them more ready of execution. In the tying of the stitches, great care must be taken not to tie them too tightly, as then they will cut out before the healing is complete and cause the wound to gape. The closure of the cleft being satisfactorily completed, the nares are thoroughly cleansed by washing them out with a sterilized salt solution, and when complete the diaphragm is introduced. This has a small hole in the side through which a silk thread is passed, which is carried around the ear to prevent the possible swallowing of the plate during sleep. The diaphragm should be frequently removed, the tongue meanwhile being controlled by a depressor, and the mouth and nares thoroughly cleansed by a mild antiseptic douche. The tensor palati is not divided, as the least disturbance of the functions of the palate seems to promise the best result in phonation. The majority of cases heal by first intention throughout. In some there is a cutting of the stitches in the middle (due, in most cases, to tying the stitches too tightly), but this gap generally closes by touching the edges with silver nitrate every second or third day. The results are most satisfactory, even if the speech is not much improved, for the chronic rhinitis due to lodgement of particles of food in the nares is ultimately cured.

The improvement in speech depends largely upon the intelligence of the patient and the subsequent elocutionary training. Patients have had results so perfect after months of training that any congenital defect was not suspected.

In some cases there is tenseness of the soft palate. This can be, to a great extent, overcome by massage and stretching by pressure with the finger. The operation can be done as soon as the six-year-old molars have erupted; and the earlier the operation, the better the prospect for improvement in speech.

Fillebrown's Method.—Fillebrown commences the incision at the upper edge of the cleft of the hard palate (Fig. 16, *a, a*), and with a hoe-knife dissects off the soft tissue, including the periosteum, as far as the dotted lines *b, b*. These flaps meet when turned down toward the median line. After paring the edges he inserts silver-wire sutures running above and through the flaps, and pure silver disks (Fig. 17, *c, c, c*). He then twists the ends and makes tension, which fully approximates

the edges.   To relieve the strain upon the soft palate, and also to allow
contraction of the arch, he makes the incision (Fig. 17, *e*) from the
tuberosity of the upper jaw to the under molar.   He cuts through the
mucous membrane with a scalpel and then separates deeper tissues
with a smooth dissector.   The edges of the cleft now held in close
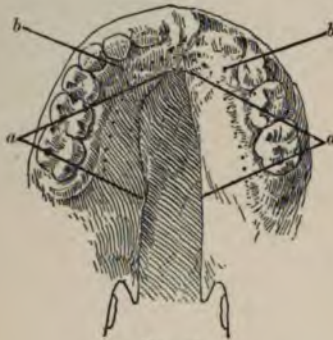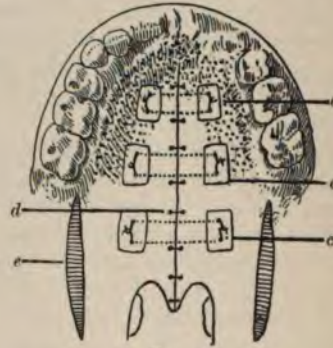
FIG. 16.   FIG. 17.

FIGS. 16, 17.—Fillebrown's operation of staphylorrhaphy.

approximation are brought more accurately together by fine silk or
membrane sutures (Fig. 17, *d*).   Thus the lateral incision in the hard
palate, the separation of the tensor muscles, and the cutting of the
pillars of the fauces are avoided, the tonsils are approximated, and
the opening of the arch is lessened.

For convenience in performing this operation Fillebrown has con-
structed an apparatus (Fig. 18) for maintaining anesthesia without
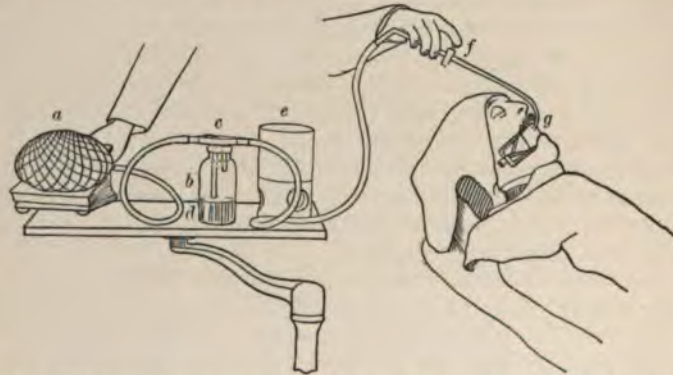
FIG. 18.—Fillebrown's apparatus for maintaining anesthesia without a face-piece, with the
patient's mouth open : *a*, bellows ; *b*, wash bottle ; *c*, valve to control strength of vapor ; *d*,
anesthetic ; *e*, warm bath to set bottle (*b*) in, to prevent freezing of the anesthetic ; *f*, valve to
stop flow of anesthetic during expiration ; *g*, tube discharging into the mouth.

interfering with operations in the mouth.   It is amply sufficient to keep
the average patient fully anesthetized.

Mechanical Appliances.—Cleft palate may also be treated by mechanical appliances
(Figs. 19 and 20).   The obturator, when successfully fitted, relieves the principal deformity—

namely, the voice, and, in the majority of cases, more effectively than is done by the operation. It can be applied at an early age, as soon as the patient has teeth to support a plate.

FIG. 19.—Plaster model of cleft of palate, a gold plate to retain in position the velum, which is made of soft, flexible rubber (Moriarty).

The patient can therefore enjoy the advantages of the obturator during the period of education.

The comparative methods of the obturator and the operation for the relief of cleft palate are still *sub judice*. The operation shuts off effectively the nasal cavity from the mouth, and generally gives satisfaction to those patients who have submitted to it. The voice is, how-

FIG. 20.—The hollow bulb or hard-rubber appliance used in the mechanical treatment of cleft palate (Moriarty).

ever, often imperfect, owing to the tension of the soft palate. It is also often necessary, in cases that have been operated upon, to wear a plate to support the teeth.

The obturator is no more inconvenient or uncomfortable than a set of false teeth, and it produces excellent results in the improvement of the voice.

Fissures.—The other forms of congenital defects usually involve only the soft parts, and are extremely rare.

AFFECTIONS OF THE LIPS, TONGUE, AND MOUTH.

Angiomata, or **nevi,** are met with upon the lip, the inner side of the cheek, and on the tongue. They are always congenital, and are usually small at first, but may in later years begin to grow and assume

FIGS. 21, 22.—Angioma of the upper lip, showing the condition after treatment as contrasted with that before.

most unsightly proportions. The above illustration was from a child ten years old treated at the Children's Hospital, Cincinnati. Reduction was effected only after treatment of a year and a half with electrolysis, seton, and puncture with the thermocautery. If small, nevi may be cut out and the edges of the wound united. If cut into, the hemorrhage is severe. If large, they may be reduced by electrolysis, one or both poles being introduced into the growth. A number of sittings are necessary. The fine point of the thermocautery plunged into the growth at a dull-red heat is more effective.

Cystic tumors of the lip, more often of the lower, are not infrequently seen. They belong to the retention-cysts of the mucous glands. The mucous membrane over them is thin, and they contain a glairy mucus. They must be dissected out and not simply opened.

Carbuncle of the Lip.—This is always a serious affection, and may produce cerebral symptoms by thrombosis of the facial vein extending to the ophthalmic vein, and thus involving the cerebral sinuses. Tension should be relieved by early and free incision, or the whole mass may be excised within the mouth.

Syphilis.—The lip is frequently the seat of the manifestations of secondary syphilis, and more rarely of chancre. Secondary syphilis usually appears as mucous patches, which are situated on the inner aspect of the lip, or as fissures in the angles of the mouth. Chancre

involves most frequently the lower lip, not infrequently in the median line. It presents at times the usual indurated base, but is prone to extensive infiltration, so that almost the entire lip may be involved, presenting an ulcerated surface. The submental and submaxillary glands always become promptly indurated. Chancre is contracted from mucous patches by kissing, by the use of pipes or drinking-utensils, or towels used by syphilitics or by children suckled by infected nurses. It yields readily to mercury, or if left alone is followed by secondary manifestations. It occurs most frequently at ages not liable to cancer, the only affection liable to be mistaken for it. A vigorous course of mercury should be given.

Cancer of the lip always occurs in the form of epithelioma. It affects the lower lip almost exclusively, and is much more common in men than in women. The use of tobacco in pipe-smoking is presumed to be the explanation of this difference, a view which is fortified by the fact reported by a number of observers that a considerable proportion of women affected have been in the habit of smoking pipes. It is most frequent from thirty-five to sixty, but it has been met with both earlier and later in life.

It appears as a nodule, a warty growth, or an ulcer. The ulcer is crater-like, with raised infiltrated edges, and, at first circumscribed, continues to extend, so that the entire lip may be affected by a mass of considerable size. The lip may be more or less extensively destroyed and the bone of the lower jaw attacked.

Regional infection occurs in the submental and submaxillary glands, either of which may be involved without the other. Further extension occurs in the deep glands along the carotid sheath, especially about the bifurcation of the common carotid. Here the affected glands may assume the proportion of a tumor of considerable size extending under the sternocleidomastoid muscle, which is usually fixed and immovable. The glands affected are usually on the side of the lip originally involved; occasionally, however, the secondary affection is on the opposite side, or both sides of the neck may present tumors. The submaxillary glands appear to be most frequently involved, and if of any size the growth can be seen beneath the jaw. The time when infection of the glands takes place must differ considerably in different cases. Secondary glandular tumors not infrequently occur after removal, even when no enlargement could be discovered at the time of operation. This fact should be borne in mind, and suggests the necessity of exploration of the submaxillary region when the growth on the lip is at all extensive. The frequency with which cancer of the lip occurs in man is to be explained by the frequent source of irritation to which the part is exposed. The diagnosis is not often in doubt. A chancre, indeed, presents often a similar appearance; its more rapid growth, the age of the patient, and the history will usually determine its character. If doubt remains, treatment will promptly remove it. If the suspicious sore has lasted beyond a few weeks without the manifestation of secondary symptoms, syphilis can be excluded. Tuberculous ulcer of the lip is very rare. Finally, a microscopical examination from the scraping of the surface, or a piece cut off, will definitely settle the nature of the growth.

The **treatment** should consist in free removal. This is best done by a V-shaped section, the healthy tissues being freely sacrificed beyond the growth. If there are any enlarged glands beneath the jaw, the submaxillary space should be freely opened by an incision which commences at the apex of the triangular incision made for the removal of the original growth, and carried across the neck to the anterior edge of the sternocleidomastoid muscle. This will enable the operator to examine the submental and submaxillary spaces thoroughly, and if any enlarged glands are found, all of the fat in which they are embedded should be freely removed. It is not sufficient simply to cut down over an enlarged gland. The entire region should be cleaned out, so as to remove all intermediate lymph-channels. In other words, the region beneath the jaw should be treated as we now treat the axilla in cancer of the breast. The resulting scar adds but little to the deformity.

If the deeper glands along the carotid sheath are enlarged, an attempt should be made without hesitation to effect their thorough removal. The sternomastoid muscle may have to be cut through and laid back, so as to expose the whole carotid sheath fully. There should be no hesitation in ligating and excising the internal jugular, and it may be even necessary to place a temporary, or even permanent, ligature on the common carotid. The exploration should reach to the root of the neck, and should be most thorough.

Wounds of the Lips and Tongue.—Wounds of the lip may be incised, from cutting instruments, or contused or lacerated, made by the teeth. They may penetrate the entire thickness of the lip and involve the vermilion border, or may affect only the cutaneous or mucous surface. The latter are frequently due to penetration of one of the teeth, the force being a blow or fall. Repair is usually satisfactory. Care should be taken to coapt the edges of the wound accurately, especially on the vermilion border and at the corners of the mouth, with fine sutures, and if the portion wounded is covered with beard, the part should be carefully shaved. In contused and lacerated wounds no part should be removed, as repair is usually very good. The tongue may be wounded through the open mouth, or by being caught between the teeth, as in an epileptic fit, or by penetration of the cheek. If the wound gapes, the parts should be carefully brought together with sutures, under cocain. In lacerated wounds mouth-washes should be used during the process of healing. If there is severe hemorrhage, the lingual artery should be secured in the wound, or if this is impossible, in the digastric triangle. Should the hemorrhage recur after ligation of the lingual, as in one case of the writer's, the external carotid should be tied.

After wounding of the tongue, foreign bodies, such as a pipe-stem or a broken tooth, may remain embedded, undiscovered for a long time, and be mistaken for a tumor from the swelling. This subsides after removal. The removal of a foreign body from the root of the tongue may be followed by severe or even fatal hemorrhage.

The tongue, uvula, and pharynx may be scalded by the inhalation of steam ; the last usually suffers the most. Iced mouth-washes are usually all that is needed. Edema of the glottis may follow burns by steam.

Tongue-tie.—This condition is not often met with in a sufficient degree to justify operation. The frenum is too short and attached too near the tip of the tongue, if present; in a marked degree it prevents the protrusion of the tongue and interferes with sucking. The operation for its relief consists in snipping the frenum with a pair of scissors directed downward, and then tearing the tissues sufficiently. If the frenum is too freely cut away, there may be danger of "tongue-swallowing."

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Macroglossia may be simulated by syphilis, the tongue being greatly enlarged by gummata. This form will yield to appropriate remedies.

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Symptoms.—Swelling rapidly occurs. The entire tongue is reddened and so much enlarged that it protrudes from the mouth, and presents an alarming and distressing appearance. Swallowing of liquids alone is possible, and even this is difficult. In extreme cases the difficulty of breathing may demand tracheotomy. The condition develops with great rapidity, and usually causes great alarm. Occasionally an abscess forms or partial gangrene occurs; usually, however, the tongue returns to its normal condition in a few days.

Treatment.—In mild cases the use of iced mouth-washes is all that is called for. Immediate relief can usually be given by a free incision on either side of the median line into the muscular tissue of the tongue, and this should be practised without hesitation, and the bleeding for a time encouraged.

Leukoplakia.—Chronic glossitis and psoriasis are the names vari-

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ously given to conditions characterized by thickened yellowish patches of various size on the dorsum of the tongue. The essential cause is obscure, but they may be associated with, and spread from, a chronic ulcer due to a ragged tooth. They are essentially chronic in their course, and may remain unchanged for a long time. Under continued irritation, such as smoking strong tobacco or using strong liquors, an epitheliomatous degeneration may occur.

Treatment.—All source of irritation should be removed, bad teeth extracted, bland food only taken, and mild mouth-washes ordered. The patches themselves should be touched with a 20 per cent. solution of potassium iodid. If they resist such treatment, free removal is to be recommended, especially if there are any ulcers or fissures.

Ranula is a cystic formation which appears as a painless swelling beneath the forepart of the tongue, usually central, but sometimes situated entirely upon one side. It is of slow, hardly perceptible growth, and the first complaints are usually on account of the inconvenience, caused by its size, in speaking and swallowing. It has been considered as due to a dilatation of the duct of the sublingual gland, and this occasionally may be the cause. Usually, however, it must be classed as a retention-cyst of the mucous glands, and caused by obliteration or obstruction of the duct. It is not likely to be mistaken for any other form of growth. Puncture will at once establish definitely the diagnosis, by the escape of a viscid, tenacious fluid. After simple puncture it promptly refills to its former size.

The proper **treatment** consists in cutting away the anterior prominent part of the wall, and then destroying the lining of the rest with a curet or cautery lightly applied. The use of a seton has been recommended, but is extremely uncertain.

Salivary Calculi.—These calculi are composed of lime and magnesium salts, and may develop in connection with any of the salivary glands, but are most frequently found in the duct of the submaxillary gland. The calculus may, however, be embedded in the gland itself, and when so found gives rise to no symptoms for an indefinite time. When it develops in Wharton's duct, it presents an enlargement or swelling on the floor of the mouth beneath the tongue, usually without pain, and the end of the calculus may even present from the opening of the duct. The secretions of the gland may accumulate to such an extent that an appreciable swelling will form beneath the jaw, which will become more or less painful. If the calculus is arrested in Stenson's duct, the parotid region and entire side of the face may be swollen to such an extent as to suggest an abscess-formation. If, as has been done, the swelling is opened with the knife, a persistent salivary fistula is apt to follow. The distention of the gland may, however, subside without the expulsion of the stone, to recur at some later date. The calculus is not infrequently spontaneously expelled and found in the mouth.

The **diagnosis** can be made by a fine probe introduced through the duct, if it happens to be patent and the opening can be found. If not, a needle, under cocain anesthesia, may be made to penetrate the overlying mucous membrane and be brought in contact with the rough surface.

The **treatment** consists of an incision over the long diameter of the stone, if this can be made out, and should be sufficient to free it fully, as it is important that it should be extracted entire, without breaking and leaving a fragment behind. The swelling in the gland usually subsides very promptly after extraction.

Stomatitis.—The mouth contains a large number of bacteria, which are for the most part entirely innocuous, even those which are pathogenic requiring certain conditions to render them active. These favoring conditions may be general and due to causes which reduce the vital powers of the patient, and so diminish the resistance of the tissue to the invasion of the ordinary pyogenic germs; or the favoring conditions may be local, such as decayed or carious teeth and the presence of tartar and decomposing bits of food between the teeth. Local and general conditions are often combined.

The varieties of stomatitis may be described as catarrhal, ulcerative, gangrenous (cancrum oris, or noma), and parasitic (thrush).

The first presents the usual conditions of a catarrhal inflammation —increased hyperemia, redness, pain, and swelling—and is usually accompanied by an increased flow of saliva. The catarrhal form may become ulcerative, or may subside without the formation of ulcers. Ulcers, when formed, are often developed about carious teeth. The catarrhal and ulcerative forms may be due to mechanical, chemical, or microbic causes; they are produced by the rough edges of decayed teeth, by the use of mercury, and are found to occur in syphilis or to follow the eruptive diseases of childhood, especially measles.

Treatment.—In catarrhal and ulcerative stomatitis the underlying cause must be sought for, and general treatment is often more effective than local. The syphilitic must be subjected to appropriate treatment; mercury must be at once stopped if the cause, and in nearly all cases the general strength must be fortified by tonics, and faults of digestion corrected. The local treatment is best carried out by mild astringent mouth-washes or the application of silver nitrate, the pain of which may be avoided by painting beforehand with cocain. Bland food only should be taken; spiced and highly seasoned food, and tobacco in adults, prohibited.

Noma, or **cancrum oris,** constitutes the gangrenous form of stomatitis. It is probably not due to any specific germ, but to the ordinary pyogenic bacteria which are constantly found in the mouth, and which are rendered virulent by some general condition of the system. Cancrum oris is most often found in badly nourished children or after severe cases of the eruptive fevers, and there are always high fever, great depression of the vital powers, and disturbance of the digestive organs, with foul breath. Locally, the lesion first appears as a dull-red spot on the gums or inside of the cheek. This spreads and turns black, and a slough soon forms, leaving a foul, spreading ulcer. The destruction of both soft parts and bone may be very great, leaving marked deformity if the patient survives. Death, however, usually supervenes within a few days.

The **treatment** must be energetic. The child should be anesthetized, and the sloughing tissue removed with forceps and scissors, and the entire diseased tissue destroyed by the cautery or nitric acid. A

generous diet with alcohol should be given.   The resulting deformity, which sometimes may be great, may be relieved by a plastic operation.

Syphilis of the Tongue.—Next to the lips the tongue is the most frequent seat of extragenital chancre.   It occurs most frequently near the tip, as an ulcer, and may or may not present the characteristic induration.   The glandular involvement rapidly ensues in the submental or submaxillary lymphatics.   It is to be distinguished from an ulcerated gumma by its rapid onset, by the implication of the lymphatics, and by the history.   To distinguish it from simple and tuberculous ulcers, it may be necessary to apply the test of treatment.   Chancre yields promptly to mercury, which should be energetically given and persisted in, as in the more usual forms of syphilis.   Smoking should be prohibited.

The tongue may also be the seat of gumma, which usually appear as slow, painless growths until ulceration takes place, when the destruction is often extremely rapid.   Gumma occurs more often far back on the dorsum than near the tip.   Less frequently it appears as an infiltration of the muscles, producing an enlargement of the entire tongue.   It occurs some years after infection, and the history may or may not aid in the diagnosis.   The glands are seldom affected.   Syphilitic lesions in other parts of the mouth may occur at the same time.   If the hard palate is the seat of gumma, perforation is apt to occur unless checked by treatment.   It may be, and indeed probably often is, mistaken for cancer, and excision has been undertaken from this mistaken diagnosis. Increasing doses of potassium iodid cause the gumma to disappear rapidly, and this agent is decisive from a diagnostic point of view.

Tuberculosis of the tongue appears as a superficial infiltration which ulcerates, producing a sore without excavation.   It may be covered with false membrane, on removing which granulations show upon the surface.   The ulcer may be surrounded with miliary deposits. There are much less surrounding induration and pain than in cancer.   It may appear as a primary or secondary lesion.   Secondary enlargement of the lymphatics of the neck is infrequent.   Its course is slow, and pain is not great. ·Search for the bacillus is by no means always successful.   If found it, of course, settles the diagnosis.

The **treatment** consists in complete extirpation of the ulcer and infiltrated tissue—best by excision.   The curet or cautery may be used.   Cases have been reported where the tongue has been removed on the supposition that the disease was epithelioma.

Cancer of the Tongue.—The tongue is one of the organs of the body most frequently affected by cancer.   The disease always occurs in the form of epithelioma.   Men are attacked much more frequently than women, and the favorite age is from forty to sixty-five, though it has been met with at twenty-five.

The disease is situated more frequently upon the edge of the tongue than the dorsum—in this differing from syphilis—and on the right side oftener than on the left.   It runs its course in about a year and a half, and death is due to exhaustion from repeated hemorrhage or from inability to take nourishment.   It is further hastened by the swallowing of the fetid discharges of the sore, and from pneumonia and septicemia.

Those affected with cancer of the tongue are in a large proportion of cases smokers, and this is found to be true in women as well as in men. In a limited number of the cases only has cancer existed previously in the family. Chronic glossitis, psoriasis, leukoma, and syphilitic lesions may all develop into cancer, and may therefore be considered as a "precancerous stage" of the disease. Persistent sores and patches of thickened epithelium upon the tongue should always, therefore, be removed if they resist treatment. The lymphatic glands are involved early in cancer of the tongue. Those most frequently affected are the submental, the submaxillary, and those at the bifurcation of the common carotid, and not infrequently those behind the mastoid process and the upper part of the sternomastoid muscle. These glandular tumors may attain considerable size, and their growth appears to bear little relation to the size of the primary cancer.

Metastatic growths seldom, if ever, appear. Recurrence is the rule after operation, and it may take place in the unhealed wound or cicatrix, or in some of the above-mentioned glands. It usually occurs on the side first affected, but may involve both sides. It has been seen within two weeks, and has been delayed five years. Operation certainly adds some months to life, and usually saves a vast amount of suffering, unless recurrence should take place in the floor of the mouth.

FIG. 24.—Cancer of the left half of the tongue and the floor of the mouth. Rapid recurrence after removal of half of the tongue.

Symptoms.—As usually seen, cancer of the tongue presents a ragged, excoriated, ulcerated surface, with hard, indurated edges, situated on the side of the tongue some way from the tip. The tissues of the tongue about the ulcer are indurated, and the discharge more or

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Those affected with cancer of the tongue are in a large proportion of cases smokers, and this is found to be true in women as well as in men. In a limited number of the cases only has cancer existed previously in the family. Chronic glossitis, psoriasis, leukoma, and syphilitic lesions may all develop into cancer, and may therefore be considered as a "precancerous stage" of the disease. Persistent sores and patches of thickened epithelium upon the tongue should always, therefore, be removed if they resist treatment. The lymphatic glands are involved early in cancer of the tongue. Those most frequently affected are the submental, the submaxillary, and those at the bifurcation of the common carotid, and not infrequently those behind the mastoid process and the upper part of the sternomastoid muscle. These glandular tumors may attain considerable size, and their growth appears to bear little relation to the size of the primary cancer.

Metastatic growths seldom, if ever, appear. Recurrence is the rule after operation, and it may take place in the unhealed wound or cicatrix, or in some of the above-mentioned glands. It usually occurs on the side first affected, but may involve both sides. It has been seen within two weeks, and has been delayed five years. Operation certainly adds some months to life, and usually saves a vast amount of suffering, unless recurrence should take place in the floor of the mouth.

FIG. 24.—Cancer of the left half of the tongue and the floor of the mouth. Rapid recurrence after removal of half of the tongue.

Symptoms.—As usually seen, cancer of the tongue presents a ragged, excoriated, ulcerated surface, with hard, indurated edges, situated on the side of the tongue some way from the tip. The tissues of the tongue about the ulcer are indurated, and the discharge more or

less foul. If the floor of the mouth is involved, the movements of the tongue are restricted and protrusion from the mouth may be impossible. Pain varies; it may be intense, and is due to the involvement of the lingual nerve. The contact of spices and hot foods or drinks, and even the act of swallowing, aggravates the suffering.

Tuberculous ulcer and broken-down gumma are the conditions most likely to be mistaken for cancer. Syphilitic treatment will cause rapid improvement in the second, and should always be tried in doubtful cases. The microscope will distinguish between cancer and tubercle. Here differentiation is not so important, as removal is indicated in both; the prognosis, however, is much better in the tuberculous ulcer. The tuberculous ulcer may, however, undergo cancerous degeneration.

The only **treatment** of cancer which pretends to be at all curative is complete and thorough extirpation, and even then recurrence is unfortunately the rule. Operation, however, is indicated, as it prolongs life and lessens suffering.

The possibility of preventing the development of cancer of the tongue should always be present in the surgeon's mind. Irritating teeth should be drawn, and persistent ulcers and carcinomatous patches should be freely removed if they resist treatment.

In very exceptional cases, when the cancerous nodule or ulcer is small and situated near the tip, the removal of a wedge-shaped piece may be all that is necessary. In the great majority of cases, however, the removal of half or the whole tongue is indicated. There are many surgeons who consider the removal of the entire tongue absolutely necessary, when any operation is proposed. The weight of authority and experience, however, seems to indicate that the removal of half the organ is fully as successful as the removal of the whole, when the growth is strictly limited to one side. If, however, it has passed the median line, all are agreed that the entire tongue must be sacrificed. Before any operation on the tongue the patient should always go through some preparatory treatment. The mouth should be thoroughly cleansed by the frequent use of mouth-washes, and the surface of the sore may be treated daily with a strong solution of zinc chlorid. The pain caused by such an application may be much lessened by the free use of cocain.

All tartar should be carefully removed and defective teeth drawn. The secretions in the mouth in these cases are often extremely foul, and are undoubtedly the cause of septic pneumonia after operation. Before the removal of the tongue the patient should be taught to feed himself by the use of a tube passed into the esophagus. It is of the utmost importance that a full supply of nourishment be introduced after the removal of the tongue, and it is equally important that this food should be free from the contaminating wound-discharges which may easily be swallowed with it. Feeding through a tube therefore becomes necessary, and it is much better that the patient should learn to do this himself. During the operation hemorrhage is usually more annoying than dangerous. The mouth fills up with blood, which obscures the field of operation, and the blood runs down the throat and gets into the larynx, causing suffocation and the consequent struggling and delay. This is best avoided by turning the patient on his

side, in a semi-prone position, during the operation. The blood then runs into the cheek and can be mopped away. Preliminary ligation of the lingual artery is, however, a perfect protection against hemorrhage, and should always be done.

The tongue has been removed by a great variety of operations. These have, however, given way to two methods—namely, the Whitehead operation, by which the removal is effected by scissors from within the mouth, and Kocher's operation, by which the floor of the mouth is opened from the submaxillary triangle and the tongue drawn through the opening and then removed. This method permits of free removal of enlarged glands and the preliminary ligation of the lingual artery. The écraseur has been shown by experience to be followed by sloughing, and has generally fallen into disfavor. Cutting through the jaw is to be advised only in exceptional cases. Destruction by cautery or electrolysis should never be undertaken.

Kocher's Method.—The patient is to be thoroughly anesthetized with chloroform. The mouth is then opened by a reliable gag and the tongue transfixed by two stout ligatures, one on either side of the median line, near the tip. The submaxillary triangle is now opened by an incision which commences behind the angle of the jaw, runs down the anterior border of the sternomastoid muscle to a level with the hyoid bone, then parallel with this bone across the neck, turning upward near the median line to end near the lower jaw. The submaxillary triangle is fully opened, and the submaxillary gland, all the lymphatics and fat being fully removed after ligating the facial artery and vein. The lingual artery is now sought for and ligated. At this stage it is well to make careful search for enlarged glands about the bifurcation of the carotid, and if any are found, the incision should be prolonged, if necessary, downward to the root of the neck, exposing the entire carotid sheath. This is imperative. Having carefully removed all suspicious lymphatics, including those in the submental space, the floor of the mouth is to be opened freely by the knife close to the jaw, the incision being carried well back of the growth on the tongue and of the part of the floor involved. The mucous membrane on the dorsum of the tongue is now split exactly in the median line well up to the tip, and the muscular tissue is then easily torn, dividing the tongue into lateral halves. The half to be removed is now drawn through the wound beneath the jaw, and is cut off with scissors behind the growth. This is usually done without bleeding. The part removed must now be carefully examined, and if it is found that the cancerous mass is everywhere surrounded by healthy tissue, the other side may be allowed to remain. If, however, there is any doubt, the other half should be removed through the same opening, the remaining lingual artery having been previously ligated. The floor of the mouth must now be most carefully examined and all suspicious tissue removed.

Kocher advised a preliminary tracheotomy, but this does not seem necessary, as the ligation of the linguals effectively controls hemorrhage, and the anesthesia need not be interrupted.

The floor of the mouth is now packed with iodoform gauze in long strips, which come out through the external wound. This may be

partly closed, well packed with gauze, and firmly bandaged. A firm bandage adds much to the comfort of the patient and facilitates swallowing. The packing in the mouth and wound must be frequently changed when it becomes saturated.

As soon as possible the patient is made to sit up, and even get out of bed, for in this way he gets rid of the saliva and discharges much more easily than in the recumbent position. A large part of the mortality which follows excision of the tongue is due to an "inhalation pneumonia." Feeding should be generous, and may be effected by a tube passed into the esophagus; and this is much better done by the patient himself. The feeding-tube avoids the contamination of the food by the wound-discharges.

The above-described operation seems best to meet the conditions of a thorough removal of all disease, and is probably to be recommended in all cases where more than a limited portion of the tongue is to be taken away. The Whitehead operation has, however, still a number of adherents, and must be described.

Whitehead's Operation.—The patient is placed against an "almost perpendicular back-rest." "The two structures which are responsible for the retention of the tongue within the mouth are the frenum and the anterior pillars of the fauces, and if these structures are divided the tongue can be so freely drawn out of the mouth that the operation is converted into an extra-oral incision."

The tongue is now rapidly separated by cutting through these structures and the floor of the mouth. All bleeding is disregarded until in the vicinity of the lingual arteries, which, according to Whitehead, can readily be distinguished and caught with forceps and twisted. This once accomplished, the separation continues without fear of hemorrhage. As a precaution, before the separation is complete, a ligature may be passed through the glosso-epiglottidean fold. Dressing is by packing the mouth with gauze saturated with Friar's balsam and iodoform. This procedure is not applicable if the glands are involved.

In cases of great glandular involvement, operation is by many considered as contra-indicated. In non-operable cases much relief of pain may be secured by a section, or resection, of the lingual nerve, or by painting the surface of the ulcer with cocain before eating or drinking.

CHAPTER II.

DISEASES OF THE JAWS AND GUMS, PHARYNX, AND TONSILS.

DISEASES OF THE JAWS AND GUMS.

Gingivitis (*Inflammation of the Gums*).—Anatomically the gums consist of a dense fibrous tissue closely connected with the periosteum of the alveolar processes—practically a thickened portion of the periosteum, which being firmly attached about the necks of the teeth, acts as a ligament and an elastic cushion to the teeth in the alveoli. This membrane is prolonged into the alveoli, lining the inner surfaces of these cavities, and is reflected upon the roots of the teeth. A smooth and vascular mucous membrane, remarkable for its limited sensibility, and continuous with the general mucous membrane of the oral cavity, covers the surface of the gum. Numerous fine papillæ are found in the gums around the necks of the teeth.

Causes.—Gingivitis may result from various causes, such as the decomposition of particles of food which, owing to defective cleansing of the mouth and teeth, collect about the necks of the teeth. It may be also caused by accumulations of tartar, by the excessive use of mercury, by chronic lead-poisoning, by scorbutus, and by alveolar abscess.

Symptoms.—In these various forms there are present the usual symptoms of inflammation—pain, heat, swelling, and discoloration—with hemorrhage, suppuration, fetid breath, and a tendency in some cases to the formation of ulcers.

Gingivitis due to tartar-formations is characterized by the deposit of lime salts, calcium phosphate and carbonate, about the necks of the teeth, near the free edge of the gums. Examinations have also detected in these deposits bacteria and "mould fungi." They are found in largest quantities and most frequently about the superior molar teeth, near which the duct of the parotid gland (Stenson's) opens, and the inner surfaces of the incisor teeth of the lower jaw, near which the ducts of the submaxillary and sublingual glands open (Wharton-Rivini). Sometimes these deposits appear in large masses. The author removed, on one occasion, a mass of such size as to conceal the molar teeth entirely; it had been mistaken for an osseous tumor. The deposits vary in color and consistence; they are sometimes yellowish and sometimes brown or black.

Mercurial gingivitis presents as characteristic features—marked swelling, excessive flow of saliva, a peculiar fetid breath, and a tendency to ulceration. Gingivitis due to chronic lead-poisoning is distinguished by the presence of the "blue" line or, as sometimes described, a "slate"-colored line along the margin of the incisor teeth, or a "pale-green"

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discoloration of the gum. Gingivitis associated with scurvy is recognized by the swelling and sponginess, with looseness of the teeth and marked tendency to hemorrhage.

Diagnosis.—The careful study of the history of each case, of the symptoms presented, and examinations of the structure involved, lead to the formation of correct diagnosis.

Treatment.—In all varieties of gingivitis the cardinal principle of the treatment is the removal of the cause. Accumulations of tartar should be removed. Patients suffering from chronic lead- or mercurial poisoning should be promptly taken from the influence of these agents. In cases of scurvy proper food and remedies appropriate to the treatment of this disease should be administered.

The treatment of the inflamed gums consists in the thorough cleansing of the teeth and the frequent use of disinfecting solutions, depletion—either local by the knife or general through the alimentary canal by cathartics—the administration of tonics, and the regulation of the diet.

Solutions of potassium chlorate, boric acid, and potassium permanganate may be employed as disinfecting agents. In the first and secondary stages of the inflammatory action the parts may be painted with iodin or with iodin and aconite solutions (equal parts), or a solution of silver nitrate (1 : 100).

Hypertrophy.—Hypertrophy of the gums occurs, as a rule, in elderly persons, and may be caused by the pressure exerted by ill-fitting artificial dentures or by the pressure exerted in chewing food in persons who are edentulous. In these cases the hypertrophy is gradual in its development, rarely painful ; it sometimes acquires large bulk, covering the greater portions of the alveolar border, especially in the upper jaw. The pathologic character of these growths is that of true hypertrophy, all of the structures of the gums participating in the excessive development.

Another form of gum hypertrophy occurs as a congenital condition in which the gums of both upper and lower jaws are affected, the masses being of such size as to cover the teeth entirely to a level with their cutting edges. This form of hypertrophy, the recorded cases show, occurs in patients of feeble intellects, undeveloped physical condition, associated, in some instances, with unusual hairy growth.

Examination of sections of these growths shows exuberant development of the papillæ with increase in the fibrous tissue. The alveolar processes are also expanded and lengthened.

Symptoms.—The prominent symptom of this affection is the interference with the mastication of food. Frequently the large size of the masses produce much discomfort.

Diagnosis.—The distinction is to be made between hypertrophy and fibroma. The symmetrical development of the former is a diagnostic point of value.

Treatment.—The treatment consists in the careful removal of the growth with the knife, thorough scraping of the bone with the Volkmann spoon, and, if necessary, excision of the alveolar border. Hemorrhage may be controlled by applications of hot water, styptics, such as tannin, subsulphate of iron, etc., the ligature, and in severe cases the

cautery.   Pressure may be, in some cases, exerted by covering the sur-
faces with layers of iodoform gauze and bringing the lower jaw firmly
in contact with the upper by a figure-of-8 bandage.

Tumors of the Gums.—Under the term "epulis" (Figs. 25, 26)
a number of tumors or growths of the gum have been described. The

FIG. 25.—Periosteal sarcoma, or epulis.

term means literally "situated on the gums," does not possess any
pathologic signification, and therefore its use should be abandoned.
As with few exceptions the so-called tumors of the gums implicate
the alveolar process, it would be more in accordance with scientific
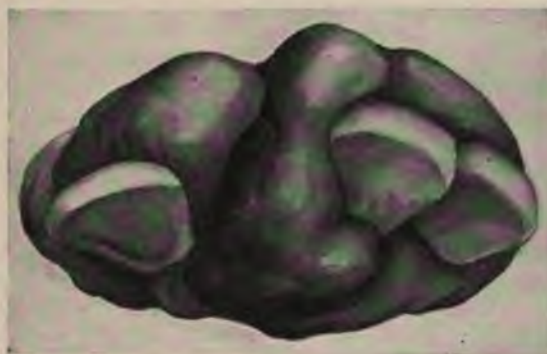
FIG. 26.—Periosteal sarcoma, or epulis.

classification to divide them into tumors of the gums and tumors of the
alveolar process.

Fibroma.—These are strictly tumors of the gums, taking origin in
the fibrous tissue and being chiefly a hyperplasia of the connective-
tissue element.   They spring from the gum between the teeth or from
the surface, and may have a pedunculated or sessile attachment. Some-
times these growths attain quite a bulk, and bleed freely owing to the
friction to which they are exposed in mastication.   Generally they are
insensitive to the touch and are not painful.

Treatment.—Excision close to the surface of the gums, with the

application of the pencil of nitrate of silver or cautery to the wound is sufficient to effect permanent relief.

Granuloma.—This term may be applied to growths which take origin from the alveoli of extracted teeth, from fistulæ, from the exposed pulp of diseased teeth, or from the healthy pulp of a fractured tooth. The latter have been designated "tumors of the pulp." The tissue which participates in the morbid growth is the connective tissue of either the pulp or the lining membrane of the alveolus. The tumors are characterized by a fungoid appearance. Those which originate from the cavities of extracted teeth, from old fistulous tracks, or from the pulp of teeth which are diseased are insensitive; while those which occur in connection with injury to the tooth which exposes the healthy pulp to the action of the air and contact with irritants are extremely sensitive as the result of the inflammation which supervenes.

Diagnosis.—Careful examination of the growth, with a view to detect its connection with the tissues of the alveolus or the pulp-cavities is necessary to a correct diagnosis.

Treatment.—The treatment consists in clearing out the morbid tissue from empty alveoli or fistulæ with the curet, and cauterizing the surfaces. Pulp-cavities should be excavated with the proper dental instruments, and the cavities filled. In the sensitive varieties local anesthetics should be employed to prevent pain.

Angiomata.—Vascular tumors of the gums may appear under two forms—in one the fibrous element predominates, and in the other it assumes the characters of a nevus or erectile growth. These tumors consist of fibrous tissue, with numerous dilated blood-vessels. They occur most frequently in children, and develop usually in connection with the anterior teeth of the upper jaw. Appearing as a bright-red pimple, they may increase in size to that of an almond, being of a purple color, of a soft, spongy consistence, and liable to bleed freely when roughly manipulated. When they occur in connection with the teeth from the pulp-cavity or from the alveolus they may be accompanied by severe pain and frequent hemorrhages.

Treatment.—Free excision should be made, the knife being carried well beyond the limit of the affected tissue, with removal of the underlying and adjacent bone by the curet or pliers, until healthy structure is reached. Hemorrhage, which is sometimes very active, may be controlled by the use of hot water, pressure with pledgets of iodoform gauze, and the actual cautery.

Papilloma.—The papillæ, which form a constituent part of the gums, in rare instances become the seat of morbid action. These growths consist of a mass of hypertrophied papillæ of the mucous membrane. They have a characteristic appearance, some of them measuring nearly an inch in length, and being of soft texture, with surface in some places ragged and in others smooth.

Treatment.—Excision, if carefully performed, so as to get beyond the limit of affected tissue, will result in permanent relief.

Epithelioma.—As a primary disease epithelioma rarely attacks the gums; when it does occur, it is usually an extension of the disease from the lower lip or cheek. When it appears as a growth of the gum, it takes origin in the epithelium of the mucous membrane and

forms irregular, sloughing ulcers, with indurated borders and of very rapid growth. Later in the course of the disease the lymphatic glands become involved. Pain of a lancinating character is present, the discharge is frequently very offensive, and there is a tendency to hemorrhage. The general health becomes eventually affected, and exhaustion supervenes.

Treatment.—The treatment consists in early and free excision, removing not only the soft structures implicated, but those adjacent, with the teeth and a section of the alveolar process. It is advised by J. Collins Warren, in cases in which the lymphatic glands are involved, to remove these, and to endeavor in any operative procedure to include in the field of operation all tissues affected.

Sarcoma.—This variety of tumor takes origin either from the periosteum, when it may be classified as a growth of the gum, or from the medulla or endosteum, when it should be regarded as an affection of the alveolar process. The tumor may be of the spindle-celled, round-celled, or giant-celled variety. The last form, constituting the myeloid sarcoma, occurs most frequently, and is sometimes associated with spindle- and round cells. The proportion of connective tissue and cells gives character to the tumors as hard or soft, and determines the relation to benign or malignant formations. They may be attached by a pedicle or by a broad base. They occur at the middle period of life, and arise oftener from the posterior surface of the gum in connection usually with the teeth of the upper jaw. The periosteal variety consists largely of connective tissue with spindle- or round cells, and is firm in consistence. The endosteal growth contains the myeloid or giant cells (see Fig. 27); it is soft, and sometimes exhibits a tendency to undergo ulceration, which gives it some of the features of a malignant growth.

Treatment.—In both varieties the treatment consists in extirpation, the soft structures and bone being divided by incision and section some

FIG. 27.—Microscopical section showing sarcomatous nature of epulis.

distance beyond the attachment of the tumors. In the periosteal variety the section of the bone may be limited to the alveolar process, but in the endosteal form it may be necessary to remove not only the process, but a portion of the body of the bone. When the disease has pervaded the antrum, it may require removal of the upper jaw to obtain complete extirpation. Operative procedures in these cases should be thorough, in order to assure freedom from recurrence.

Alveolar Abscess.—Strict definition limits alveolar abscess to a

collection of pus at the apex of the root of a tooth. The lining membrane of the internal surface of the alveolus, as well as that covering the root of the tooth, may become the seat of inflammation at any point, and suppuration may result, constituting alveolar abscess.

Causes.—Exposure of the pulp in a carious tooth to the influence of the air and to the contact of foreign bodies, as particles of food, etc., excites inflammatory action in the pulp, which is conveyed by continuity of structure through the canal of the root to the tissues surrounding the apex. The same condition may arise from a badly filled tooth, inflammation taking place in tissues which have not been removed from the pulp-cavity or canal of the root. Inflammation occurring in any part of the alveolus may be caused by violence.

Symptoms.—The symptoms may be studied in connection with the three stages of inflammatory action. In the beginning of the stage the symptoms are those which characterize engorgement of the delicate blood-vessels of the involved structures. Pain of an acute character is most marked—throbbing and lancinating; heat with redness and swelling is present in the soft tissues covering the process adjacent to the affected tooth. Swelling of the face ensues, and persists until the inflammatory action subsides. The swollen alveolo-dental membrane causes the tooth to project from the cavity, and efforts to replace it by pressure are accompanied by severe pain.

In the second stage, when plastic exudation has occurred, there is an abatement in the severity of the pain, and the other symptoms are less pronounced, with the exception of swelling, which may be increased by deposit of the exudate. The alveolo-dental membrane is increased in thickness by this deposit, and, as a result, the extrusion of the tooth is more marked.

In the third stage, resolution occurring, the symptoms gradually disappear and the parts assume their normal condition. If suppuration supervenes, the symptoms which indicate the presence of pus appear. This event may be ushered in with a rigor, followed by an elevation of temperature and increase in the pulse-rate. The pain is greatly increased by the tension produced by the pus confined in the small space at the apex of the root. The pus accumulating makes an effort to escape by the way of least resistance, which may be through the canal of the root into the exposed pulp-cavity, or by the side of the root at the margin of the gum. When these avenues of escape are not available, absorption of the walls of the alveolus takes place; a small opening is thus made, and through this the pus leaves the cavity, reaching usually the surface on the buccal side of the mouth-cavity. Decrease in the pain attends the escape of the pus from the alveolus. Marked swelling of the face is frequently present, with closure of the eye on the affected side, partial or complete, and closure of the jaws to a greater or less extent.

The pointing of the abscess varies according to the teeth affected. In the upper jaw abscesses connected with the anterior teeth may point over the hard palate or into the nasal cavities. Those associated with the posterior teeth may open upon the face, in front of the anterior border of the masseter muscle or into the cavity of the antrum. In abscesses of the teeth of the lower jaw the pus may descend by gravity

to the base of the bone, pointing at this place or in the neck, or even so low down as the upper border of the clavicle.

Diagnosis.—Usually the diagnosis of alveolar abscess is not difficult. The presence of a diseased tooth with pulp-cavity exposed, or of a tooth which has been filled, with localized symptoms of inflammation, distinguish the condition from periostitis. When the abscess has opened spontaneously and a sinus has formed, it may be difficult to decide which tooth has been the exciting cause, if there should happen to be more than one in a diseased condition. In such cases a careful examination is necessary to arrive at a correct diagnosis.

Treatment.—In the initial stage the treatment consists in the prompt removal of the cause and the adoption of such measures as will promote resolution. If the offending tooth can be saved, it should be treated by removing the diseased pulp, or the filling, if it is a filled tooth, clearing out the canals of the roots, injecting with antiseptic solutions, and introducing temporary fillings. If the tooth is too much diseased to be saved by such measures, it should be promptly extracted. This will at once stop the progress of the inflammatory action. Conjoined with the treatment of the tooth, local and general measures, for the purpose of combating the inflammation, should be resorted to. Local depletion by division with the bistoury of the inflamed tissues overlying the affected tooth, the application of leeches, or the frequent use of hot water in the mouth, will unload the congested blood-vessels and afford relief to the pain. In severe cases it may be desirable to employ active purgation to assist the local measures adopted.

When exudation has occurred the use of absorbents is indicated, as the application of tincture of iodin over the parts. In this stage section of the inflamed tissues may avail.

Under no circumstances should hot fomentations be applied over the face, as such applications invite the pointing of the pus to this surface. The surface of the face when swollen should be painted with the pure tincture of iodin or equal parts of iodin and alcohol.

When suppuration has supervened and the pus has not escaped from the cavity of the alveolus, an effort may be made by clearing out the pulp-chamber and canals of the root to secure its removal through the tooth. If an abscess-cavity has formed outside of the alveolus, its early evacuation into the cavity of the mouth is demanded, in order to prevent pointing upon the surface, with the resulting formation of a scar. Frequently sinuses persist after the spontaneous opening of alveolar abscesses. In these cases careful examination of the mouth should be made to detect the affected tooth and secure its treatment or removal.

Periostitis.—Inflammation of the periosteum of the jaws may occur in the acute or chronic form. In the former the causes may be the irritation of diseased teeth, eruption of the permanent teeth, trauma, specific poison, such as occurs in the exanthematous diseases, tuberculosis, ptyalism, or phosphorus vapor. In the chronic form the most frequent cause is the poison of syphilis. In both forms the alveolo-dental membrane may become involved, inducing conditions relating to the teeth.

Symptoms.—Intense pain of a diffused character, heat in the part

affected, swelling of the overlying tissues and face, with general constitutional disturbance.

Diagnosis.—Careful examination of the teeth and tissues covering the bone, with inquiry as to exposure to a cause, will assist in making the diagnosis.

Treatment.—In the acute variety prompt interference is necessary in order to prevent the occurrence of suppuration with the resulting dangers of necrosis. Prompt depletion by general and local measures should be employed. Hot-water fomentations, the application of leeches, and free incisions with the bistoury should constitute the local treatment, while the systemic treatment should be conducted by the administration of saline cathartics and sedatives to allay pain.

In the chronic form potassium iodid should be administered in increasing doses until the pain is relieved and the swelling subsides. Incisions are also of service in promoting absorption. Where a syphilitic taint of the system is present and the symptoms do not yield, mercury, preferably the bichlorid, should be combined with potassium iodid.

In periostitis of the chronic form due to syphilis, caution is to be observed in the extraction of teeth, as such operations are very liable to be followed by acute conditions resulting in suppuration and necrosis. Specific remedies should be administered for some time before tooth-extraction is performed.

Antrum-empyema.—Abscess of the antrum may occur as the result of blows over the cavity, injury to the alveolar process which opens the cavity or, as is most frequently the cause, the transmission of inflammatory action from carious teeth which are in relation with the antrum. The teeth in most intimate relation are the second bicuspid and first and second molars. Occasionally inflammation may be imparted from a diseased canine tooth or first bicuspid.

Symptoms.—The symptoms indicating suppuration in the antrum are marked, being those which attend inflammation in any other part—heat, pain increased on pressure, redness and swelling.

Diagnosis.—In some cases the diagnosis is difficult, although the history of the case, presenting a definite cause with the symptoms of inflammatory action, guides to a correct conclusion. The escape of pus from the nasal fossa of the affected side, with the absence of any condition in the fossa to account for it, is of diagnostic value. The presence of a carious tooth in relation with the cavity in an inflamed state will assist in making the diagnosis. The condition of the canine fossa should be carefully examined into, in order to determine the presence of pus in the antrum. Its obliteration, by the bulging out of the anterior wall, indicates that the cavity is occupied, and the resiliency of this wall under pressure determines the question whether fluid or a solid growth is within. It may be expedient, where doubt exists, to employ the transillumination test, a small electric lamp of high candle-power being introduced into the mouth, the patient being in a dark room or with the head covered with a dark cloth. If the antrum is empty when the lamp is lighted and the lips are closed, a translucent curved band of light immediately appears beneath each eyelid.

Treatment.—The treatment consists in prompt evacuation of the

pus, with the use of douches of hot water and antiseptic solutions, and in some instances packing with 5 per cent. iodoform gauze. Access to the antrum may be obtained through the nasal fossa or through the mouth. The operation through the mouth is in every way preferable, as through this cavity thorough drainage can be obtained, and the cavity of the antrum more readily and conveniently douched or packed. With a trocar of proper size an opening can be made above the position of the first molar tooth, through the anterior wall. If any one of the three teeth in intimate relation with the cavity is in a diseased condition, and if, possibly, it has been the cause of the inflammation in the antrum, it should be extracted, and an opening made with trocar or drill through the alveolus. Care should be taken to guard with the index finger the distance to which the instrument enters the cavity.

Necrosis.—Various causes are concerned in the production of this affection of the bones of the jaws. Among these are injury, the irritation of diseased teeth, badly treated fractures of the jaw, tuberculosis, syphilis, scorbutus, rheumatism, excessive use of mercury, fumes of phosphorus, attacks of acute exanthemata and typhoid fever. In some instances the extent to which the bone is involved may be very slight and its character superficial, while in other cases, especially in the lower jaw, one-half, two-thirds, or the entire bone may be implicated, as well as both the compact and cancellated structure. The lower jaw is more frequently attacked than the upper.

The pathologic condition leading to necrosis may originate either in the endosteum or periosteum, developing such interference with the nutrition of the bone through the blood-vessels of these tissues as will result in the death of the bone. By reason of the extension of the periosteum into the alveoli, forming the alveolo-dental membrane, suppurative action invades these cavities, and the teeth become loosened and either fall out or may be removed with slight effort. In the affection described as pyorrhœa alveolaris these conditions are present. In necrosis of the lower jaw the sequestrum and involucrum are formed as in the shaft of long bones, while in the upper jaw new bone is not formed, but fibrous tissue partially fills up the cavities left after the removal of the dead bone. This difference may be accounted for by the difference in structure between the upper and lower jaws. The former, formed as it is largely of thin plates of compact tissue, is but slightly vascular. The latter consists of masses of cancellated tissue covered by dense layers of compact tissue, in this respect resembling the structure of the long bones. The new bone formed in necrosis of the lower jaw is sufficiently strong to carry the weight of an artificial denture.

Symptoms.—The symptoms of necrosis are usually well marked. These are the presence of suppuration, with swelling of the alveolar processes, loosening of the teeth in the alveoli, and marked constitutional disturbances.

Diagnosis.—Careful inquiry as to a cause, with a study of the history of the case and examinations of the cavity of the mouth, will lead to a diagnosis.

Treatment.—During the stage of suppuration which accompanies the separation of the sequestrum, measures should be adopted to keep the mouth scrupulously cleansed by the use of antiseptic solutions, and tonic remedies should be administered, conjoined with good diet, nutrients, and exercise in the open air, to combat the harmful effects of the suppurative action. Efforts should be made by the prompt incision in the mouth of pus-cavities to prevent pointing upon the face. As a rule, it is advisable to await complete separation of the sequestrum before making attempts to remove it. In some cases where the morbid action

is intense, it may be advisable to interfere before separation occurs, with the hope that by such measures the necrotic action may be limited, if not stopped. In all cases operations for the removal of the sequestra should be performed through the mouth. In the lower jaw, care should be employed to preserve intact the newly formed bone.

Phosphorus-necrosis.—In the *Transactions of the American Surgical Association for 1885* the author stated his views, based upon

FIG. 28.—Phosphorus-necrosis of one-half of the lower jaw.

a large experience, on this subject. In this paper he expressed the opinion that the effect exerted upon persons exposed to the fumes of phosphorus was rather more general in character than local—that a constitutional impression was made by the poison, which specially implicated the periosteum and placed that structure in a morbid con-

FIG. 29.—Phosphorus-necrosis; right half and portion of left half to first molar removed.

dition, ready to undergo inflammatory action in the presence of an exciting cause. The conditions most prone to excite inflammatory action are tartar-accumulations about the necks of the teeth, and diseased teeth with exposed pulps. The influence of these causes in the production of periostitis, with resulting necrosis, is similar to that

manifested in syphilitic affections of the tertiary form in which the periosteum is involved.

The action of the poison through the system upon the periosteum has been found to affect morbidly the vessels of the structure, in this way exerting an important influence over the nutrition of the bone. The toxic effects of phosphorus on the organs and structures of the body, as the liver, heart, and arteries, have been definitely established. The author therefore believes there exists a primary morbid condition of the periosteum and bone, the result of a systemic infection, and that the irritation developed by the conditions stated becomes the exciting cause of the inflammatory action, and that it does not occur in consequence of the direct action of the inhaled fumes upon the periosteum of the jaw.

FIG. 30.—Phosphorus-necrosis of the entire lower jaw.

Prophylaxis.—As the disease occurs, as a rule, among operatives in match factories, the prevention may be accomplished first, by the enactment of such laws as will control the conditions which surround the operatives, compelling perfect ventilation and hygienic surroundings, cleanliness of the hands at the time of eating, and careful supervision of the teeth ; and second, in the use of the more easily oxydizable form of phosphorus, the red amorphous in the place of the yellow. Rare instances are recorded in which the disease has appeared as the result of the contact of articles with matches, the patients habitually putting these into the mouth. Prevention in such cases is easily obtainable.

Symptoms.—The symptoms of phosphorus-necrosis differ from those of ordinary necrosis mainly in intensity. The pain, which is one of the earliest symptoms, is at first intermittent, but in time becomes continuous. The first and second stages are, as a rule, rapidly passed through, and suppurative periostitis with osteitis manifests itself, causing the teeth to become loose and pus to exude from the alveoli. The inflammation quickly extends, involving the structures of the gums and detaching them so as to expose the alveolar border. Infiltration of the tissues of the face follows, and swelling occurs. Soon the inflammation invades the entire periosteal membrane, the formation of the laminated bone can be distinguished, and offensive discharges escape into the mouth. When the lower jaw is affected the pus may gravitate to the base, and escape by sinuses at this point or at some point lower down the neck. If the inflammation involves the condyle of the lower jaw, pain

is experienced in the ear of the affected side, and closure of the jaws may become complete. The general health of the patient becomes deteriorated in a marked degree, and death may ensue from exhaustion or, in very severe cases, from gangrene of the overlying soft structures. In rare instances the disease may assume a chronic form, and the general health may be maintained during a period of years, whilst the sequestrum slowly disintegrates, and the débris is carried off through sinuses.

Diagnosis.—The history of the case, establishing the fact of exposure to the toxic effects of phosphorus, renders the diagnosis easy. A pumice-like appearance of the sequestrum and of the new bone-formation has been described as characteristic of this form of necrosis. The author has observed this deposit on some of the specimens removed by him, but not on all.

Treatment.—The treatment of phosphorus-necrosis should be conducted on the same general plan as in ordinary necrosis. In the beginning stage the treatment should be directed to the condition of the teeth. If collections of tartar exist about the necks, they should be carefully and gently removed. Diseased teeth should receive careful treatment, so as to relieve the sensitive conditions which exist and to avoid by gentle manipulation the development of peridental inflammation. Temporary fillings should be inserted until such time as it may be prudent to employ those of more permanent character. Extraction of diseased teeth should be performed with the greatest care. If possible, it should be avoided, owing to the danger of provoking inflammation by the laceration of the structure. The soft tissues should be bathed with antiseptic and astringent solutions.

The constitutional treatment should consist in the administration of remedies to relieve pain and promote the general health, and of agents which may possess the power to neutralize the effects of the poison and arrest the disease. The commercial oil of turpentine has been shown by experimentation to possess antidotal power. The patient should be removed at once from the influence of the poison. When the inflammation of the periosteum is well established, measures should be taken to arrest the action and thus limit the destruction of bone. Active antiphlogistic measures are indicated, free incisions of the periosteum should be made, and internal remedies administered to combat the inflammatory action.

If the inflammation passes to the suppurative stage, the treatment should be supportive and expectant, awaiting the separation of the sequestrum. Efforts to remove the necrosed bone before this occurs should not be attempted, as experience shows that these, as a rule, will result in an extension of the disease. Cleansing of the mouth by frequent use of hot water and antiseptic solutions should be practised. The sequestrum should be removed through the mouth, care being taken to separate the laminæ of new bone, so that they will not be fractured or drawn away with the sequestrum. When the condyloid and coronoid processes of the lower jaw are involved, disarticulation is effected by dividing the structures in front of the ramus. In some instances it may be necessary to divide the ligaments of the articulation with the probe-pointed bistoury.

Hyperostosis (*Leontiasis Ossea*).—This rare affection usually occurs in connection with the maxillæ. In some instances the bones of the skull are all more or less involved. In these cases the cavities of the cranium and of the face are encroached upon by the thickened bones, the eyeball may be forced out of the orbit, and the nasal fossæ become markedly obstructed. Nerves which traverse canals in the bones affected are so compressed by the encroaching bony walls that their function becomes destroyed. Sometimes the enlargement of the bones

FIG. 31.—Leontiasis ossea (cast in Warren Museum).

is uniform, and again it occurs in masses or bosses, producing great deformity (Fig. 31).

The pathologic character of the disease has not yet been definitely determined. Heath regards it as taking origin in an inflammatory affection of the periosteum which leads to the deposit of new bone and the expansion and filling up of the original osseous structure. By others it is viewed as a manifestation of syphilis or rachitis.

The disease manifests itself at an early period of life and advances very slowly. Its presence is not usually recognized until deformity appears as the result of the increasing thickness of the bone or of the bony masses.

Treatment.—Internal remedies are ineffectual in arresting the progress of the disease. In some instances the upper jaw has been extirpated. The bony masses may be exposed and removed by the chisel.

Cysts.—Cystic disease appears in the jaws in connection with the teeth and in the substance of the bone.

Two forms of cysts are described which are connected with the

teeth—the first, with completely developed teeth, and the second, those in which the teeth are in process of development and have not erupted.

The first form is of inflammatory origin, occurring at the apex of diseased teeth. The peridental membrane is detached from the root and forms a sac which contains fluid. The cysts vary in size; in most instances they are small. In one case recorded by Heath, a cyst attached to the apex of the root of the last molar tooth of the upper jaw filled the whole antrum.

The second variety of cyst connected with the teeth, the *dentigerous* cyst proper, is described by Tomes as caused by "the detachment of the investing soft tissue from the enamel surface of the tooth by a small quantity of transparent fluid which not uncommonly collects in the interval so formed. This fluid is discharged when the tooth is erupted; but when from some cause the eruption of the tooth is prevented, it increases in quantity, gradually distending the surrounding tissues in the form of a cyst." As the result of this detachment of the membrane, the tooth is displaced and falls to the bottom of the cyst. Sometimes suppuration occurs in these sacs, and pus may escape from spontaneous openings. Again, the cyst-cavity may be small, little or no fluid present, and the tooth firmly fastened in it, producing the condition known as an impacted tooth. The cysts may occur in connection with any of the teeth, but most frequently with the anterior teeth. They may occupy the alveolar process, project into the antrum, or, in rare instances, form in the palatine process of the superior maxilla, on the floor of the nasal cavity, or in the roof of the mouth. In three cases operated upon by the author in his clinic during the past year, the teeth involved were the canine. All were firmly impacted, and section of the teeth showed imperfectly developed canals with the absence of pulp-chambers.

Symptoms.—The symptoms which attend dentigerous cysts are the presence of swelling, fluctuation, which may be elicited by pressure with the fingers, sometimes a crackling sound when the wall is thin, slow growth, painless character, and the absence of a permanent tooth.

Diagnosis.—The diagnostic point of most value is the absence of a permanent tooth. This, however, is not pathognomonic, as it sometimes happens that the absence of the full complement of teeth may be accidental or may belong to the individual as a matter of hereditation. Occasionally a temporary tooth occupies the position of a permanent one, and careful examination should always be made in order to detect this condition. Exploration with the exploring needle or incision into the cysts will confirm the diagnosis in any case.

Treatment.—In the case of the inflammatory cysts developed at the apex of the roots of the teeth, extraction reveals the presence of the cyst and effects a cure.

In dentigerous cysts, in which the encasing wall of bone is thin, they may be incised by a strong bistoury, or if the bone is thick and strong, by the chisel, and the cysts emptied of their contents. The cyst should then be cleansed with hot water and disinfecting solutions and packed with 5 per cent. iodoform gauze. Where the contained

tooth is firmly impacted, it should be carefully removed with the elevator or forceps, so as to avoid injury to the roots of adjacent teeth. If the cyst-cavity is large and much deformity exists, the walls should

FIG. 32.—Cystic tumor of the jaw, probably dentigerous (Warren Museum).

be crushed in, in this way obliterating the cavity by approximation of its sides.

Cysts of the Lower Jaw.—Owing to the structure of the upper jaw cysts of the bone rarely, if ever, occur. In the lower jaw this form of cyst originates in the cancellated tissue of the bone. Heath believes the cause to be some irritation connected with the roots of the teeth, a cancellus expanding and producing gradual absorption and obliteration of those adjacent, until a cyst of considerable size is formed. They may be unilocular or multilocular and contain usually a viscid fluid. Sometimes they produce great deformity by their size.

Symptoms.—They are of slow growth and of painless character. Fluctuation may sometimes be determined, with crackling of the wall when thin.

Diagnosis.—Careful examination should be made to differentiate from other forms of tumors. Through error in some cases one half of the jaw has been excised, an operation not justifiable for this condition. Exploration with small trocar or needle should be made if any doubt exists.

Treatment.—Cysts of the lower jaw should be treated in the manner advocated by J. Mason Warren, by incision within the mouth, removal of the contents by the curet, and obliteration of the cavity by crushing in the walls. In addition to these measures he advised the use of injections to maintain a sufficient degree of irritation to favor the deposition of new bone.

Tumors.—The upper and lower jaws are very frequently the seat of tumors, both of the benign and malignant character. The morbid

growths may be developed from the external or internal surface, from the body, or from the alveolar border.

Tumors of the alveolar process have been treated of in connection with diseases of this portion of the jaws (page 45).

Fibroma.—This form takes origin either in the periosteum or medulla. It may occur as a pure fibrous growth or possess a mixed

FIG. 33.—Fibroma of the upper jaw, caused by blow.

character, containing in some instances masses of cartilage, spiculæ of bone, or cysts. It may also be associated with sarcoma, forming

FIG. 34.—Fibroma of the upper jaw perforating the hard palate (Warren Museum).

in these various combinations chondrofibromas, osteofibromas, fibrosarcomas, and fibromyxomas.

Fibrous tumors may develop in the antrum as lobulated masses and by their expansion enter the cavity of the nose or eye, or protrude through the facial surface or the hard palate.

Symptoms. — Fibromas are characterized by the symptoms of benign tumors—slow growth, painlessness, the absence of any tendency to infiltrate the surrounding tissues, firm, unyielding consistence, and absence of any tendency to undergo ulceration. They produce no constitutional depression.

Diagnosis.—The diagnosis is made by a careful examination of the

growth and a study of its history. In this manner it may be distinguished from sarcoma of the more malignant type and from carcinoma.

Treatment.—When these growths occupy the external surface, especially if small, either pedunculated or sessile, they may be exposed and removed through the mouth. They may be removed from the cavity of the antrum by a similar operation, the anterior wall of the cavity being divided by a strong bistoury or chisel. If very large, it is advisable to expose them by section of the cheek and detach them by the periosteal knife or elevator. In cases of recurring fibroma, it is necessary that an operation of greater extent should be performed, the bone being widely cut away and thoroughly scraped with the curet.

Enchondroma.—As a pure growth this variety is extremely rare. It occurs most frequently as a mixed tumor, in combination with the fibroma, myxoma, and osteoma. It may attain enormous size, and when developed in connection with the upper jaw, it may invade the various cavities of the face. Usually it appears in early life.

Symptoms.—The symptoms of enchondroma are similar to those of fibroma, and are such as belong to benign growths. Appearance at an early period of life, tardy growth, absence of pain, and indisposition

Fig. 35.—Osteoma.

to undergo ulceration, with firm consistence are the principal symptoms. The general health is not affected.

Diagnosis.—During life and prior to operation it is difficult to distinguish this form of tumor from those which belong to the benign group.

Treatment.—Extirpation at as early a period in the history of the tumor as possible is the proper treatment, before it has caused destruction of adjacent structures by its expansion.

Osteoma.—Osseous tumors or exostoses may develop in connection with either jaw and from any portion. Cases of osteomata of the antrum have been recorded by a number of observers. Osseous tumors occur mostly in old or middle-aged subjects, and are produced by external violence resulting in diffuse inflammation of the periosteum. Formerly a syphilitic taint of the system was believed to be concerned in their production. Their attachment to the bone is by a broad base, and they often grow to an enormous size.

Symptoms.—The tumor is essentially local in character, and possesses all of the characteristic features of a benign growth. Excessive hardness is a peculiarity. The general health is unaffected.

Diagnosis.—Osteomata are to be differentiated from leontiasis ossea, ossifying periosteal sarcomata, and odontomes of large size. Their extreme hardness distinguishes them from fibromata and enchondromata. When doubt exists, the introduction of an exploring needle will determine the character of the growth by the resistance offered.

Treatment.—Exposure by incisions through the mouth, and in the case of antral tumors, division of the anterior wall of the cavity, with elevation by the chisel or elevator, constitute the methods of treatment to be pursued. If, owing to large size, such procedure is not practicable, the tumor should be uncovered by division of the overlying structures and removed by the chisel.

Sarcoma.—Of the different varieties of tumors which attack the jaws the sarcomatous are by far the most common, and in their diverse

FIG. 36.—Sarcoma of the antrum.

forms they occur at all periods of life from infancy to old age. They appear in connection with the different portions of the bones. When developed from the alveolar border they constitute the sarcomatous epulides which have already been described (p. 45). Sarcomatous

growths may be peripheral or central in origin, and may be developed from the periosteum or the medulla.

Two forms of periosteal sarcoma, differing in pathologic character, present themselves. The first, a dense, firm, and smooth growth, consists of spindle-celled tissue combined sometimes with giant cells and spiculæ of bone, giving it on section the appearance of an osteofibroma. Tumors of this variety occur in young subjects, are usually the result of injury to the parts, and are of slow and painless growth. The second form of periosteal sarcoma consists of small round cells with spindle-cells; it is of softer consistency, of rapid growth, attaining large size in a short period of time, and may occur at late periods of life. When it originates in the antrum it expands the walls of that cavity by its growth, and may project into the nose, mouth, pharynx, or even into the cranial cavity. Central sarcoma or myeloid sarcoma occurs most frequently in the lower jaw, and takes origin from the medulla, separating and expanding the plates of the bone which form a capsule for it. After a time this capsule becomes absorbed, and the growth may project into the cavities of the face or externally. The growth belongs to early life, and is rarely seen after middle life. It consists of giant cells embedded in a stroma of spindle-celled tissue, with occasionally a few round cells. On section it presents a succulent surface of a greenish tint. When it invades the overlying soft structures it presents an appearance closely resembling medullary carcinoma. In some cases the tumors are very vascular, the vessels enlarged, giving a pulsating character to the mass.

Symptoms.—The symptoms of sarcomatous tumors vary with the pathologic character. The firm periosteal growth, consisting of spindle-

FIG. 37.—Central or myeloid sarcoma of the upper jaw; perforation below.

FIG. 38.—Sarcoma of the body of the lower jaw.

celled structures, presents the symptoms of the class of benign tumors. Those of the softer forms—round- and giant-celled varieties—possess features more or less characteristic of carcinomatous growths.

Diagnosis.—Sarcomata of the different types are to be distinguished from fibroma, osteofibroma, cystic degenerations, and carcinomatous affections. The history of the case, with the symptoms, age, and physical characteristics presented, should be carefully considered in arriving at a diagnosis.

Treatment.—The treatment should be conducted in accordance with the character of the growth. The tendency manifested by all forms of sarcomata to recur should warn the surgeon against any procedures other than those which involve not only the removal of the growth, but, to a greater or less extent, of the bone from which it springs. In some cases in which a general invasion of the surrounding structures

exists, no operation short of extirpation of the entire bone, in the upper jaw, and of one-half or more, in the lower jaw, should be performed. It may be possible frequently in cases of small tumors to expose them sufficiently and remove them thoroughly by operation through the mouth. This method, which avoids external cicatrices, desirable as it

FIG. 39.—Periosteal sarcoma of the lower jaw, showing osteophytes (Harrington's case).

may be, should not be employed if the more important matter, the complete extirpation of the morbid growth, is in any way endangered.

Carcinoma.—The discussion of carcinomatous affections of the jaws may be limited to the considerations of the epitheliomata, as the occurrence of the other forms is so rare as to make their existence problematical. Epithelioma is a disease of later periods of life, and may appear without any assignable cause. It is usually limited in position to the maxillary sinus or the alveolar or palate processes, taking origin in the glands of the mucous membranes. When it originates in the antrum, its rapidly increasing bulk projects the walls of the cavity in all directions, permitting the growth to enter and occupy the cavities of the face or the cavity of the cranium and protrude as a large mass on the face, in this manner producing great deformity. As the disease advances, ulcerative action supervenes, copious offensive discharges occur, accompanied in some instances by hemorrhages. In the later stages the adjacent lymphatic glands become involved and may also undergo ulceration. The systemic condition of the patient rapidly degenerates, the strength diminishes, pain is often very severe, a peculiar expression of the countenance, cadaver-like, appears, and finally death results from exhaustion. On section the mass exhibits a soft consistence and grayish color.

Symptoms.—The symptoms are marked—in all respects characteristic of malignant growths, as manifested in rapid growth, presence of pain, and disposition to infiltrate the surrounding structures and undergo ulceration. The grave constitutional involvement, with the accompanying conditions of extreme exhaustion, is a characteristic symptom.

Diagnosis.—The diagnosis is not difficult. The symptoms are so pronounced in their characters as to make the differentiation from all varieties of tumors easy.

Treatment.—In the very early stages of the disease excision may be performed with the promise of arresting its progress. If performed, the operation should include wide removal of adjacent structures, in order to get beyond the limit of the morbid tissue. Partial and incomplete operations should under no circumstances be undertaken, as they provoke renewed activity of the disease. In the late stages operative procedures are justified for the purpose of relieving suffering from the intolerable conditions present, and of possibly prolonging life.

The Teeth.—The care of the teeth and the treatment of the diseases from which they suffer belong so exclusively to the domain of dentistry that but little is left for the consideration of the general surgeon.

During the progress of the first dentition the surgeon is called upon to relieve the *irritation produced by the eruption of the teeth,* by division, with the gum-lancet or bistoury, of the overlying gum-tissue. Very serious symptoms are often present, and grave complications sometimes attend difficult and delayed eruptions—as disturbances of the brain, stomach, and intestines, resulting in convulsions and coma. A single incision, the knife carried into the tissues until it comes in contact with the tooth, is sufficient for the incisior and canine teeth, whilst for the bicuspid and molar a crucial incision is required.

Difficult eruption of the wisdom tooth in adult life gives rise frequently to serious conditions, as trismus with excessive pain, swelling of the face, and constitutional disturbance. The condition may be due to the dense character of the overlying gum-tissue or to an absence of sufficient space in the alveolar border to accommodate the tooth.

The *treatment* consists in the free division of the gum, or preferably the removal of the tooth, the patient having been placed under the influence of an anesthetic agent, and the mouth opened by wedges or the gag.

Deformities.—Deformities of various kinds may occur in the teeth. These conditions consist in displacements outward of the incisor teeth of the lower jaw, due to the habit of thumb-sucking during infancy, imperfect development of the jaw, or too long retention of the deciduous teeth. The *treatment* consists in the removal of the cause, and the adoption of appliances exerting continuous pressure in order to force the teeth into their proper position.

Fusions of the roots of the teeth, with bent or divergent roots, are conditions sometimes met with, and give rise to difficulty in extraction.

Supernumerary teeth occur, as a rule, in connection with the anterior teeth of the upper jaw, and by their malposition produce much deformity. They are usually ill developed, and the proper treatment is their extraction. An absence in the full complement of teeth is sometimes observed as a matter of heredity. *Abnormal enlargement* sometimes occurs in connection with the incisor and molar teeth, giving rise to an unsightly appearance. *Notched teeth,* described by Jonathan Hutchinson, are seen in the deciduous and permanent set of teeth of the subjects of hereditary syphilis.

Dislocation.—As the result of external violence a tooth may be

dislocated. Sometimes this occurs in ill-directed efforts at extraction. Immediate replacement should be made, the alveolus having been completely cleansed and the tooth cleansed and disinfected. It should be pressed into the socket with firmness and the jaws held together by a firm bandage.

As the result of great violence a tooth may be forced through its socket. This accident is most liable to occur in connection with the teeth of the upper jaw which are in intimate relation with the maxillary sinus. They can be drawn into position with the forceps.

Fracture.—Fracture may be produced by violence, as by a blow or fall, or by the effort made in masticating hard substances. The crown or the root of the tooth may be broken. When the former is fractured it should be cut away and an artificial crown attached to the root by pivots and band. After fracture of the root, union takes place as in bone.

Caries.—This very common affection of the tooth may be in either the enamel or in the dentine beneath. The investigations of Miller have shown that the active cause exists in bacteria which are found in the mouth in large number.

The predisposing causes are defective condition of the enamel exposing the dentine, absorption of the enamel due to pressure from crowded teeth, and the presence of food and substances between the teeth in a state of decomposition. Pregnancy, ill health, digestive disturbances, and hereditary conditions are also predisposing causes. Among the exciting causes may be included acid condition of the secretions in the mouth and the invasion of the dentine after exposure by microorganisms, as the Leptothrix buccalis.

Exposure of the dentine gives rise to a condition described as sensitive dentine, accompanied by pain. When the pulp-cavity is opened the exposure of the pulp to atmospheric influences and the contact with particles of food provoke inflammation. As the result excessive pain occurs, owing to the pressure exerted in the pulp-cavity.

The *treatment* of caries is the work of the dentist, and consists in the excavation of the cavity formed, so as to remove all diseased tissue, and then in the filling of it with some material that will exclude the agencies concerned in the production of the morbid action. When the pulp is involved, it is important that this, with the contents of the root-canals, should be completely removed, in order that no tissue should remain to undergo decomposition and thus provoke inflammatory action.

The prevention of caries by the frequent and proper cleansing of the mouth and teeth with tooth-brush and antiseptic solutions and tooth-powders, so as to remove all particles of food from the mouth and the spaces between the teeth, and the care of the general health are matters of paramount importance at all periods of life.

Necrosis.—External violence, certain morbid conditions, as syphilis and scorbutus, and the excessive use of mercury may destroy the vascular supply to the teeth and result in necrosis. A marked change in color occurs. The teeth assume a dull yellowish, brownish, or blackish hue, and eventually become detached from the alveolus. If, by their presence, irritation is produced, they should be extracted.

Odontalgia.—Toothache may occur in connection with inflammation at the apex of the root of the tooth, as the result of exposure of the pulp, or of morbid conditions in this structure. In all cases of odontalgia the cause should be carefully investigated, and efforts by treatment instituted before extraction is resorted to. To afford temporary relief, pledgets of absorbent cotton saturated with chloroform, oil of cloves, creasote, or carbolic acid may be introduced into the cavities, and the gum painted with equal parts of tincture of iodin and tincture of aconite. The patient should consult the dentist without delay, in order that treatment for permanent relief may be promptly instituted.

Extraction of Teeth.—This is an operation which the surgeon may be called on to perform for conditions other than caries of the teeth, such as occur in connection with the extirpation of morbid growths, and various operations on the jaws. Simple as it may seem, it is an operation which, in its proper performance, requires judgment and skill.

Dislocations at the temporomaxillary articulation, fracture of the alveolar process of the upper jaw to such extent as to open the maxillary sinus, and complete fracture of the lower jaw, have been recorded as accidents attending unskilled efforts at extraction. Skill, united with properly applied force, is required for successful performance of the operation. Owing to the abnormal condition of the roots of the teeth, it may be impossible in certain cases to perform extraction without greater or less laceration of the process. In performing extraction the gum about the tooth should be incised and the forceps, adapted by the construction of its beaks to the particular tooth, should be applied as near as possible to the neck of the tooth. In the extraction of the incisor and canine teeth rotation with traction should be employed. Lateral motion with traction should be used in dislodging the bicuspid and molar teeth.

Hemorrhage after Extraction.—Ordinarily the hemorrhage following tooth-extraction is slight and ceases spontaneously. In some cases, however, it may be profuse and continue for some time, causing anxiety. In persons suffering from hemophilia or purpura hæmorrhagica the bleeding may be so persistent as to cause a fatal result. Extraction should not be performed in persons suffering from the hemorrhagic diathesis.

The methods of *treatment* employed in arresting hemorrhage after tooth-extraction consist in plugging the cavity with pieces of sponge, cotton, or gauze which have been charged with some styptic, as solutions of alum, tannin, subsulphate of iron, confining the plug in position with a compress between the teeth, and holding the lower jaw firmly against the upper by a roller bandage over the head. If these measures are not effective, the cavity may be touched freely with the pencil of nitrate of silver, or the actual cautery may be applied. Conjoined with these measures ergot may be given internally. Digital compression of the common carotid artery may be employed, and finally ligature of the vessel may be resorted to in order to avert a fatal termination.

Odontomata (*Tooth-tumors*).—These tumors consist of the tissues entering into the composition of the teeth—enamel, dentine, and cementum—in varying proportions, and their enveloping membranes, and take origin from the germs of teeth or from those which are in the process of growth. Sutton describes seven varieties, among them the *follicular odontome*, which has already been considered under the head of the Dentigerous Cyst (p. 54 and Fig. 32). The wall of the cyst is represented by the follicle of a tooth which has not erupted, and the tooth either partially or completely developed rests in the cyst usually in an abnormal position. In the compound follicular odontome the thickened capsules of one or more non-erupted teeth unite and undergo ossification separately. Such cysts usually contain numerous denticles with

small masses of cementum. The *epithelial* odontome resembles the cyst of the lower jaw already described (p. 55). They consist of a collection of cysts which contain a viscid fluid of brownish color. When ulceration of the mucous membrane covering them occurs, they have the appearance of epithelioma, and may be mistaken for myeloid sarcoma.

In some instances the fibrous sac of the tooth in which it is developed becomes thickened, and thus prevents the eruption of the tooth, forming the fibrous odontome. These tumors are cystic in character, and on examination are found to consist largely of fibrous tissue.

Cementomes are odontomatous tumors consisting of cementum in which the tooth is embedded. Radiated odontomes are tumors connected with the roots of the teeth, and are described usually as exostoses which consist of cementum. Cementomes are occasionally found in the human subject, more frequently in the horse and lower order of animals. Composite odontomes, the most interesting variety of the group, consist of the elements of the

FIG. 40.—Composite odontoma of upper jaw, removed by two operations (Warren Museum).

tooth-germ, enamel, dentine, and cementum, fused together in an irregular mass. They may arise from one or more germs of the teeth, and do not possess any resemblance in shape to the teeth. They, however, possess the features of the teeth so far as relates to the process of eruption which they attempt, creating symptoms which direct attention to their character. They appear more frequently in the lower jaw. In the upper jaw they grow to a larger size, and in some cases occupy and fill the cavity of the antrum.

Odontomes are encapsulated growths, and manifest the symptoms of benign tumors. Their differentiation from other tumors is important in order that the proper operative procedures should be undertaken. Enucleation can be in all instances effected with little or no sacrifice of the bone. Excision of the jaw, which, under a mistaken diagnosis, has been performed, is not justifiable. Careful examination should always be made, therefore, to determine the character of the growth.

Closure of the Jaws.—This affection occurs in two forms—the spasmodic, or temporary, and the chronic, or permanent. The former is usually the result of some condition which affects the motor filaments of the third division of the fifth nerve, causing spasmodic contraction of the elevator muscles of the lower jaw. Among the causes may be enumerated the delayed or difficult eruption of the third molar or wisdom tooth of the lower jaw, tumors of the jaws, alveolar abscess in connection with the posterior teeth, necrosis of the jaws, suppurative tonsillitis, and, finally, tetanus. The treatment of the temporary form of jaw-closure consists in the removal of the causes. In cases of impeded eruption of the wisdom teeth the mouth should be opened by levers, the patient being placed under the influence of an anesthetic, and the offending organ, which is not infrequently found to be an imperfectly developed tooth, extracted. For the removal of the other causes stated the treatment is obvious.

Permanent jaw-closure may be due to conditions which attach the alveolar processes of the jaws firmly together or to those involving the temporomaxillary articulation. Union of the alveolar borders may be accomplished through the formation of cicatricial tissue or of an osseous band. The former is the result of inflammation attacking a portion of the entire buccal mucous membrane, in former years caused most frequently by the excessive use of calomel producing severe ptyalism. The formation of the osseous band may depend upon injury to the parts or arthritic inflammation, leading to the deposit of plastic matter and the conversion of their substance into osseous tissue. The bridge of bone may exist between the alveolar borders or extend from the lower jaw to the temporal bone. Jaw-closure due to ankylosis of the temporomaxillary articulation may occur as a result of inflammation attacking the joint, frequently rheumatic in character, or as the result of inflammation following injuries, as blows or fracture of the neck of the condyle of the jaw.

The pathologic conditions causing jaw-closure may exist on one or on both sides—unilateral or bilateral.

The **symptoms** are marked and the **diagnosis** is not difficult. Where it is due to involvement of the joints, it may be in some cases difficult to decide which one is affected. The history of the case, with a careful examination of the parts, will remove the difficulties. Deviation of the jaw to the affected side sometimes occurs. When this symptom is present it will aid in making a diagnosis.

The **treatment** of jaw-closure has claimed much attention and has taxed the ingenuity and skill of the surgeon from the beginning of operative interference. For the relief of jaw-closure due to cicatricial contraction the simple division of the bands was employed, but without permanent result, re-formation of the cicatrix inevitably occurring, with greater contraction. Excision of the cicatricial mass, with and without the transplantation of mucous membrane or integument, has been equally unsuccessful. The formation of a false joint in the body of the bone in front of the cicatrix, advocated by Esmarch in 1851, and practised by himself and Rizzoli, accomplished, when the false joint was successfully made, the opening of one-half of the mouth to slight extent. This operation is of no avail when the affection is

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bilateral.   The employment of the external incision produces a disfiguring cicatrix, especially objectionable in females (Fig. 41).

The author has overcome the difficulties attending the accomplishment of successful results in these cases by the following method of

FIG. 41.—Operation in front of cicatrix, opening but one-half of the mouth and leaving cicatrix.

operation : At the time of operation the cicatricial mass is freely divided on one or both sides, as the case may be, and by the means of wedges and levers the mouth opened to the fullest extent.   A long-handled, slightly curved needle, armed with a strong aseptic twisted silk ligature of sufficient length, is introduced at the angle of the mouth on the inner surface and carried carefully into the space between the cicatricial mass and buccinator muscle, the point being made to emerge at the position of the last molar tooth of the lower jaw.   The ligature is now seized with the forceps, the needle withdrawn, and the ends are tied, the ligature lying loosely in the channel thus formed.   The spaces formed by the division of the cicatricial mass are now packed with strips of 5 per cent. iodoform gauze.   The purpose being to form behind the cicatricial tissue a canal lined by mucous membrane, the ligature is drawn backward and forward, and a curved probe is from time to time passed through it.   At the end of three days the mouth-gag is gently used, and its use thereafter continued daily, increasing gradually the extent to which the mouth is opened (Fig. 42).   At the end of the third or fourth week a grooved director, curved in proper manner, is introduced into the canal, and a blunt-pointed bistoury is carried along the groove, dividing the remaining cicatricial tissue as it advances.   At this time it will be found that the canal is lined with mucous membrane, so that reunion of the divided cicatricial tissue cannot occur.   In order that the function of the muscles, joints, and other tissues, which by reason

of long disuse have become rigid, may be restored, the patient is required to continue the use of the gag for a period ranging from two to three months. In the meantime the alveolar processes, from which irregular and distorted teeth have been removed, have undergone absorption and are ready for the adaptation of artificial dentures (Fig. 43).

FIG. 42.—Author's gag.

FIG. 43.—Result after division of cicatricial tissue.

The treatment of *jaw-closure due to the formation of an osseous bridge* consists in the section of the bridge with the metacarpal saw and the use of the gag to open the mouth and restore the function of the disused structures. If the mass is large the segments may be removed with the chisel or dental burr.

In *fibrous ankylosis of the temporomaxillary articulation*, causing jaw-closure, the treatment consists in the use of force to break up the adhesions, the patient being under the influence of an anesthetic, and the restoration of the function of the joint by passive motion.

Jaw-closure due to osseous ankylosis may be relieved by exsection of the condyle by an external incision. Simple section of the ramus as practised by Diffenbach is not sufficient, owing to the difficulty of establishing a permanent false joint by this method. In order to secure a freely movable and permanent false joint the author has practised the following method of operation: An opening being made beneath the masseter muscle, $\frac{1}{3}$ to $\frac{1}{2}$ inch above the level of the crown of the last molar tooth of the lower jaw, a blunt-pointed bistoury is passed from within the mouth, separating the muscle to sufficient extent to introduce the Adams saw. With this

FIG. 44.—Impression of mouth before operation.

instrument the ramus is divided, if the section is made on the line

given, $\frac{1}{4}$ inch above the position of the inferior denta
into which passes the inferior dental artery and nerve. Int
ing made the lion-jawed forceps are introduced and the upp
seized.   The blunt-pointed bistoury is used to divide the p
sertion of the temporal and external pterygoid muscles, a
is made to twist the segment out of position.   The cavity
the removal of the upper segment of the ramus is packed
cent.iodoform gauze, which serves the purpose of separating
and expanding it, as well as of controlling any hemorrhage

FIG. 45.—Closure of twenty-seven years'
duration, due to osseous ankylosis of tem-
poromaxillary articulation, showing non-
development of lower jaw.

FIG. 46.—Result after ope
ion of upper third of ramu
and coronoid process of ja
mouth.

occur.   Repacking of the cavity should be practised on th
and every second day thereafter, disinfecting solutions bei
cleanse it.   The gag should be used to overcome the rig
opposite joint and of the muscles, occurring as the resul
Lateral displacement of the jaw does not follow the rem
upper portion of the ramus, and the joint formed is cap
freely movable.

DISEASES OF THE PHARYNX AND TONSILS.

Pharyngitis.—Acute catarrhal inflammation of the
generally associated with that of the palate and tonsils. A
pendent affection it may be caused by cold, by the ingestic
rosive substance or of hot water, or by the inhalation of st

The **symptoms** vary with the intensity of the disease
cases the patient experiences a sensation which he describes
throat," with difficult deglutition, a " hawking " cough, a
secretion of thick, tenacious mucus. In severe cases, incr
and spasm are present, with regurgitation on attempts at
Hoarseness of the voice occurs with swelling of the neck
base of the jaw and below the ear.   The lining membrane
deep-red color, the follicles are enlarged, and ropy mucus,
sionally plastic matter, covers the surface.   The constituti

toms are marked in some instances. The inflammation may extend through the Eustachian tube to the middle ear, producing " otitis media " along with the symptoms referable to this disease.

The **treatment** of pharyngitis consists in the use of constitutional and local remedies. It should begin with the administration of a brisk cathartic, followed by anodyne and diaphoretic agents. Local remedies, antiseptic, astringent, and detergent, should be applied by inhalation, as sprays, washes, and by painting with brush or sponge. Wet compresses or an ice-bag may be applied around the neck. Tincture of the chlorid of iron and chlorid of potassium may be given internally in the severer forms.

Follicular Pharyngitis.—In this form, which is usually consequent upon repeated attacks of acute catarrhal pharyngitis, associated with declining health or pulmonary disease, the follicles or lymphadenoid tissue in the mucous membrane become hypertrophied by infiltration. The hypertrophied follicles, as the disease advances, increase in size, and form by their coalescence numerous elevations on the pharyngeal surface, which may extend to the fauces and nasopharynx. In the exudative variety the follicles become filled with cheesy contents, consisting of disintegrated epithelial cells and small calcareous particles. Granular pharyngitis is called commonly clergymen's sore throat, as this class of men is thought to be more subject than any other to the affection. It sometimes appears as one of the manifestations of specific disease.

Symptoms of digestive disorders, persistent cough, with deterioration of the general health, usually attend the presence of follicular pharyngitis. An inspection of the pharynx leads to the determination of the diagnosis.

The **treatment** includes the use of constitutional and local remedies. If a cause can be ascertained to exist, it must be removed. Internal remedies should be administered with a view to correct any disorders of the digestive tract, and to restore the patient's general health change of mode of life and climate is sometimes required. The use of alcohol and tobacco should be interdicted, and rest from use of the voice in public speaking should be enjoined.

The local treatment should have for its object the promotion of absorption of the hypertrophied tissues. For this purpose iodin and its preparations are indicated as local applications. Nitrate of silver in a solution of 40 grains to the ounce of water may be applied cautiously to the surface with a brush to stimulate the absorptive action. Tincture of the chlorid of iron in undiluted form is of value as a local application by reason of its energetic astringent power. Astringents, as alum and tannin in solution, may be used in the form of spray or by insufflation. If the disease fails to yield to the usual methods of treatment, the hypertrophied follicles may be destroyed by very careful application of caustic remedies or by the Paquelin cautery. When dependent upon a syphilitic taint of the system specific remedies should be administered.

Membranous (Diphtheritic) Pharyngitis.—This form of pharyngitis is characterized by the formation of a membrane upon the surface of the mucous membrane of the pharynx. This membrane, as

recent investigations have established, is formed by the diphtheria bacillus, discovered by Löffler, and begins in small, circular, grayish-white patches, which increase in extent and finally coalesce, often covering the soft palate, tonsils, and pharynx. The membrane may be thrown off and recovery ensue, or a fatal termination may take place as a result of an extension of the disease to the larynx and bronchi, and of systemic intoxication by the toxins engendered by the bacilli or infectious myocarditis, producing heart-paralysis (Tillmans). In the mild form, which has been termed membranous croup, the superficial layer of the mucous membrane is involved. In the severer form (diphtheria) the entire membrane is affected. The inflammatory product consists of fibrin and cells, and in the one instance rests upon the mucous membrane, while in the other it infiltrates the mucous membrane. It is a local infectious disease, and occurs in certain localities in the endemic and epidemic forms. In the severe form the toxemic effect upon the general system may be profound, causing glandular involvement, pneumonia, myocarditis, diarrhea, albuminuria, and paralysis, local and general. The membrane may extend into the nose, through the Eustachian tube into the middle ear, into the mouth, through the esophagus, into the stomach, into the larynx and bronchi, establishing the most serious complications.

The **symptoms** are so marked as to render the diagnosis comparatively easy. A positive diagnosis can be made only by a bacteriological examination, which should be made in every case.

The **treatment** of diphtheritic pharyngitis relates to the adoption of local measures and remedies to combat the systemic infection. The patient should be isolated and kept under the best sanitary conditions. The local measures which may be employed are very numerous, as are also the constitutional remedies which have from time to time been administered. Inhalations of the vapor from slacked lime have been used with a view to dissolve the inflammatory membrane. Solutions of lime water, lactic acid, and lysol are also used as washes and gargles. The application of tincture of chlorid of iron, nitrate of silver, diluted carbolic acid, 1 : 1000 solutions of bichlorid of mercury, glycerin-bichlorid solution (1 : 20), solutions of hydrogen peroxid in equal parts of water, and other disinfectant and astringent remedies may be employed. A single injection of a solution (1 : 500) of bichlorid of mercury into the tonsils and glands under the jaw has been recommended by Nepveu. Tillmans advises the destruction of each diphtheritic focus at the beginning by the actual cautery, the patient being under an anesthetic. Tracheotomy and intubation should be employed in the very early stages of laryngeal invasion. The most encouraging results have been obtained by the injection of the antitoxin agent, Behring's serum. The injection, on one or two occasions in the interval of twelve hours, in the quantity of 10 cubic centimeters or 500 units or more, should be made under antiseptic precautions in the wall of the abdomen or in the back between the scapulæ. The systemic treatment should consist of the administration of tonics, tincture of chlorid of iron and quinin, and stimulants. Nutritious, concentrated food should be given, if necessary by the stomach-tube introduced through the nose. Potassium chlorate has been much used as an internal remedy, also minute doses of calo-

mel frequently repeated. In epidemic invasion the dissemination of the disease should be prevented by vigorous sanitary regulations.

Tonsillitis.—Acute inflammation of the tonsils occurs very frequently, and at all periods of life and seasons of the year. It is especially prevalent among young persons and in the winter and spring months. It exists under two forms, the superficial (peritonsillar) and the deep, or follicular and parenchymatous. Membranous tonsillitis occurs in connection with membranous pharyngitis and diphtheritic inflammations of the soft palate and associated parts. It begins usually with the involvement of one tonsil; in a few days the other is attacked. When both are simultaneously affected, it is generally an indication of septic infection. The causes concerned in the production of the disease are exposure to cold in wet weather, to the influence of unsanitary conditions, impure air, and sexual excitement. It occurs also in connection with strumous taints of the system and rheumatic and gouty diatheses.

The **symptoms** vary with the form. In both, the attack is ushered in with a chill, followed by pyrexia with the attendant conditions. The symptoms characterizing the affection follow in rapid succession. Dryness of the throat, difficult and painful deglutition, impeded respiration and snoring, hoarseness, enlargement of the glands of the neck, with pain on pressure, abundance of ropy adhesive secretion, the effort to dislodge which causes pain, stiffness of the neck, and inability to open the mouth fully. Inspection of the parts shows the tonsils enlarged, of deep-red color, and covered with patches of lymph which give the appearance of ulceration.

In parenchymatous tonsillitis these symptoms are intensified and the progress of the disease, unless interfered with, leads to suppuration. Follicular tonsillitis is usually of short duration and yields promptly to treatment.

The **treatment** consists in the adoption of prompt and vigorous measures to arrest the progress of the inflammatory action, and thus prevent suppuration. In mild cases, a hot foot-bath, with an opiate at night and a saline cathartic in the morning, the patient remaining indoors, will frequently terminate the affection. Astringent gargles will also be of service.

When the inflammation is intense, active purgative and local depletion, by incision and scarifications, may be required to relieve the tension. Remedies should be applied locally, in the form of solutions, by means of a brush or mop, in order to cover the surfaces completely. Among these, the tincture of iodin, diluted with equal parts of alcohol, oil of turpentine, a solution of nitrate of silver (30 grains to the ounce of water), and the ammoniated tincture of guaiacum, as advocated by D. Hayes Agnew. Inhalations of steam and sprays of astringent agents are also of value. Compresses of cloths wrung out of ice-water, or the ice-bag placed about the neck, are soothing and of decided advantage in combating the inflammation. When the inflammation is due to rheumatic or gouty conditions, the treatment should include the administration of remedies appropriate to these diseases. When suppuration occurs, the abscess should be promptly evacuated, a sharp-pointed straight bistoury or the tenotome being used for this purpose. The

puncture should be made at the most prominent point, the surgeon bearing clearly in mind the position of the internal carotid artery and its relation to the base of the tonsil. The knife should be directed inward toward the median line of the fauces, and not outward toward the neck.

Peritonsillar Abscess.—Inflammation beginning in the tissue surrounding the tonsil, if not controlled by treatment, passes on rapidly to suppuration, and the pus occupying the space in which the tonsil rests may burrow into the surrounding tissue of the throat and neck.

The symptoms attending inflammation in this position are similar to those presented in tonsillitis, and the treatment should be conducted upon the same principles.

Hypertrophy of the Uvula.—The uvula is subject to attacks of acute inflammation, which occurs usually in conjunction with a similar condition of the tonsils and soft palate. Edema of the uvula occurs under these conditions, producing elongation and hypertrophy. As the result of repeated attacks of inflammation, or from debility, chronic hypertrophy may ensue. In these cases the uvula is much increased in size and length, and very disagreeable effects may arise from the contact of the elongated organ with the base of the tongue, the rima glottidis, or the posterior wall of the pharynx.

The **symptoms** provoked by this condition are irritation of the fauces, dryness of the mucous membrane, and irritative cough.

Treatment.—Local remedies are of little avail in restoring the organ to a normal condition. The only effective treatment is amputation, which may be easily performed by seizing the organ with the toothed forceps and removing the necessary portion with the probe-pointed scissors. In some cases nearly the whole of the uvula has been removed without producing any interference with deglutition or articulation. Sufficient should be removed to obtain relief from the conditions present and to avoid the repetition of the operation.

Hypertrophy of the Tonsils.—This affection occurs most frequently in young children, and occasional instances of its occurrence as a congenital condition have been recorded. It follows repeated attacks of inflammation, especially in those of a tubercular taint of the system. The effect of the inflammatory action produces a hyperplastic condition of the lymphadenoid tissue of the gland, associated with enlargement and induration. The glands may increase in size, so as to meet in the median line of the fauces.

The **symptoms** attending hypertrophy of the tonsils are well-defined. A characteristic expression of the countenance exists, with difficult respiration and nasal articulation. Warren has directed attention to a deformity of the chest which occurs in children suffering from hypertrophy of the tonsils and adenoid growths in the naso-pharynx (pigeon-breast). This condition is due to the increased activity of the diaphragm, owing to the obstruction offered in the fauces and nose. Masses of disintegrated epithelium occupy the crypts of the glands and give rise to an offensive odor from the mouth. As the result of the mouth-breathing, the mouth, fauces, and pharynx become dry, and the last is covered with inspissated mucus, the efforts to dis-

lodge which produces sometimes retching and vomiting.   Reflex neuroses may occur as the result of hypertrophied tonsils.

The **treatment** of hypertrophy of the tonsils consists in the removal of a portion of the gland either by caustics, electrolysis, or the knife. Harrison Allen restricted abscission to the removal of the hardened cortex and the slitting up of closed canals, after which the coarse lobules were removed: by others, simple incision is advised. Removal by caustic application is not only a slow but also a painful process.

The electric cautery may be used with good effect. Excision may be performed with the tonsillotome or bistoury. When the latter is used the gland is seized with the vulsellum, drawn inward and forward, and that portion projecting beyond the arches of the palate removed by a downward incision with a probe-pointed bistoury. When the tonsillotome is used the ring is slipped over the tonsil and the instrument adjusted so as to include the portion projecting beyond the arches of the palate. The stylet transfixes the mass, and the knife is withdrawn or pushed forward, making the section.

Usually but slight hemorrhage follows the operation. If bleeding persists, pressure should be made, astringent gargles of alum or of gallic acid used, and the surfaces touched with turpentine, subsulphate of iron, or alcohol. These measures failing, the actual cautery may be applied, and in cases where the hemorrhage endangers life the common carotid artery should be ligated. This is always necessary where the internal carotid artery has been wounded in the performance of excision.

Tumors of the Tonsils.—Cysts.—Cystic disease of the tonsils is rare.   Allen reports a case in which, owing to an enlarged condition of the tonsil, accompanied by excessive pharyngeal irritation of long standing, he excised the cortex and opened a cyst the size of a small chestnut, which contained a large quantity of glairy fluid, relieving the irritation at once.

Sarcoma.—Round-celled sarcomata of malignant type attack the tonsils, and are characterized by ulceration and sloughing.   They occur most frequently in the middle period of life and in association with general lymphosarcoma.   Their course is very rapid, glandular infiltration occurring very soon in the progress of the affection.

*Treatment.—*In the very early stages extirpation, either through the mouth or the neck—the latter preferably—may be performed with some promise of success. If the condition is associated with general lymphosarcoma, operation should not be undertaken unless to relieve impending suffocation or grave complications. Extirpation through the neck may be accomplished by the methods of operation practised by Cheever, Langenbeck, or Mikulicz.   The incisions may be made over the

FIG. 47.—Extirpation of the tonsils: *a*, Langenbeck's incision; *b*, Mikulicz's incision.

ramus of the jaw (Langenbeck), or from below the mastoid process

along the anterior border of the sternocleidomastoid muscle to the greater cornu of the hyoid bone (Mikulicz) (Fig. 47). The inferior maxilla is divided with a chain-saw in front of the insertion of the masseter muscle and the ramus turned out, giving free access to the deeper portions of the field of operation. On reaching the mucous membrane of the pharynx, this is opened by an incision, and the tumor is removed. Mikulicz advises preliminary tracheotomy and packing of the pharynx with gauze, in order that deep narcosis may be maintained. Very little hemorrhage accompanies the operation, if care is used in the dissection. The fragments of the jaw are wired, and the wound is drained with strips of iodoform gauze. In the removal of a large retropharyngeal tumor the author found this method of operation quite devoid of difficulties.

Carcinoma.—Carcinoma of the tonsil rarely occurs as a primary affection, being usually an extension of the disease from the palate, tongue, gum, or cheek. The tumor presents all of the features of a malignant growth, and is, as a rule, epithelial in character. Rapid infiltration of the adjacent tissues and of the glands of the neck takes place, interfering with articulation, deglutition, and respiration. Repeated hemorrhages occur, exhausting the patient, and with impeded respiration lead finally to a fatal termination.

Removal of the tumor by operation is justifiable only in the very early stages and before infiltration of the surrounding tissues has occurred. In the later stages operation may relieve for a short time the suffering of the patient or render his death less terrible. If any operation is performed, it should be through the neck.

Lingual Tonsil.—The tissue at the base of the tongue, which is analogous to the tonsil, is liable to undergo inflammation in cases of chronic pharyngitis, hypertrophy of the tonsils, or laryngitis. Nodules varying in size from that of a pea to that of a bean appear on either side of the glosso-epiglottic ligament. Removal is best effected by the galvanocautery.

Acute inflammation of the lingual tonsil may occur and provoke glossitis and edema of the glottis. Suppuration may ensue as the result of inflammatory action. The treatment of the affection of lingual tonsil is similar to that of the tonsil proper.

Fauces.—Syphilis of the soft palate and pharynx manifests itself in the secondary, tertiary, or inherited form. In the secondary form it appears as mucous patches—pearl-covered elevations with red margins —on the surface.

Gummata, the manifestations of tertiary syphilis, are developed in the submucosa of the palate or of the pharynx. Under antisyphilitic treatment they may disappear. More frequently they undergo ulceration, and form gummatous ulcers which are rapid in their progress of development and very destructive in their action on the tissues. Perforation of the soft palate may occur in a short time by the ulcerative action. As a result of the process of healing of the ulcers, union may occur between the soft palate and posterior walls of the pharynx, shutting off the nasal fossæ from the pharynx; or union may take place between the base of the tongue and the sides of the pharynx, producing stenosis of the pharynx. The openings into the esophagus or the

larynx may be constricted by the formation of cicatricial bands. These conditions interfere very much with respiration, deglutition, and articulation. In the subjects of hereditary syphilis ulcerative action of similar character takes place and produces similar conditions.

The *treatment* consists in the employment of constitutional and local measures. A vigorous antisyphilitic course of treatment should be instituted with potassium iodid and, in some cases, mercury. The local treatment should include scraping, cauterization of the ulcers, and the use of antiseptic solutions. Operations for the relief of the strictures may be performed by incisions, excisions, and dilatation.

Tuberculosis.—Tuberculosis of the fauces always coexists with tuberculosis of the lungs or larynx, or with general tuberculosis of the body. In the beginning of the disease small tubercles appear on the mucous membrane, accompanied by thickening of the membrane. These enlarge and finally undergo ulceration, forming ulcers of varying size, with cheesy bases, on the soft palate, tonsils, and pharyngeal walls. Glandular involvement is likely to occur.

Tubercular ulceration of the fauces is to be distinguished from syphilitic ulceration. The presence of the disease in other organs, associated with a more painful character and a more marked inflammatory reaction on the part of the ulcers, is a point of diagnostic value. The positive diagnosis can be made by the detection of the tubercle bacillus. The *treatment* is general and local. The general treatment consists in the administration of creasote, iodid of iron, with cod-liver oil, and the adoption of such measures as to food, mode of life, and climate as will arrest the progress of the disease or, at least, hold it in abeyance. Locally, the application by inhalations of carbolic acid in weak solution, potassium chlorate, or other disinfectants, this treatment being preceded by cauterization with the galvanocautery, will be of service. Dusting with iodoform and touching with nitrate of silver are also recommended.

Foreign Bodies.—Foreign bodies when swallowed, by accident or design, may become impacted in the pharynx and give rise to symptoms of dysphagia, pain, dyspnea, and, in severe cases, asphyxia. If the surface of the foreign body has points upon it, or if it remains long in position, ulceration may ensue, followed by serious hemorrhage. Small foreign bodies, such as fish- or chicken-bones, pins, needles, and bristles from tooth-brushes, may lodge on the root of the tongue, between the arches of the palate, or in the crypts of the tonsils. Larger substances, such as artificial dentures, coins, and pieces of meat, may rest in the pharynx or about the opening of the larynx.

Irritative cough, hoarseness of the voice, frequent attempts at swallowing, anxious expression of the countenance, and anxiety are the symptoms which attend the lodgement of foreign bodies in the pharynx.

Removal of foreign bodies from the fauces may be accomplished by the finger, blunt-pointed hooks, forceps of suitable construction, or probang. When small and beyond view, the laryngoscopic mirror should be used to assist in detecting them. When seized, gentle traction should be employed to dislodge the substance. If it is large, lateral and rotary movements with traction should be made; if long and

sharp-pointed, an effort should be made to withdraw it in the long axis of the cavity, in order to avoid penetration of the walls of the cavity, adjacent organs, or blood-vessels.

Sometimes removal may be effected by the use of emetics. If deglutition is impaired, the hypodermic injection of apomorphin may be resorted to for the purpose of producing emesis.

Tumors of Fauces.—Various forms of tumors originate in the soft palate and pharynx. Of the benign variety, that most common is the adenoma. Fibroma, chondroma, papilloma, lipoma, and cystoma are rare.

Of the malignant group, epithelioma occurs most frequently, and usually as an extension from adjacent structures. Sarcoma is very rare.

Adenoma occurs in the form of small masses on the vault and sides of the pharynx and on the arches of the palate. Their presence gives rise to a constant hawking and expectoration of a greenish-yellow mucus, and when a large number occupy the nasopharyngeal space, difficulty in respiration ensues. They may be easily detected by inspection of the throat, aided by the laryngoscope. When soft, they may be removed by the application of a solution of nitrate of silver or scraped off with the finger-nail. When firm, they may be destroyed by the galvanocautery or removed by the sharp spoon.

Epitheliomatous growths present all of the features which characterize them in other structures. In cases in which interference with deglutition or respiration occurs, removal may be effected by the curet, or preferably by the operation of subhyoidean pharyngotomy.

The entire pharynx may be removed by Langenbeck's method of operation after preliminary tracheotomy has been performed. By this method the tube is reached through an incision carried from the middle of the lower jaw downward across the greater cornu of the hyoid bone to the cricoid cartilage. The lingual and thyroid arteries and facial vein are ligated, and the attachment of the digastric and stylohyoid muscles is severed. The tube is now exposed, and can be removed after section and separation from its lateral and posterior attachments.

Sarcoma of the round-celled variety occurs occasionally as a tumor of the fauces. The disease progresses as in other situations, and the growth may be removed through the mouth or by the subhyoidean operation.

CHAPTER III.

SURGERY OF THE NOSE.

Much of the beauty of the face depends upon the size and symmetry of the nose, a nearly vertical arch of bone and cartilage, covered with flesh and integument, placed as a protection before the nasal fossæ. The latter are two wedge-shaped cavities of irregular form, which extend backward to the pharynx and subserve two purposes, that of an organ of special sense and that of purifying, saturating with moisture, and warming the inspired air. The air enters the nasal fossæ anteriorly through the nostrils, two apertures at the inferior extremity of the nose, and passes into the pharynx through two openings, the posterior nares. The nasal fossæ are separated by the septum nasi, a thin partition composed of bone and cartilage, which forms the inner wall of each. The roof of each fossa is narrow and arched from before backward; the floor is broader, more nearly level, and forms the roof of the mouth. The outer wall presents three thin, scroll-shaped, bony shelves, the turbinate bones, three meatus, and the openings which lead to the accessory sinuses and the lacrimal sac. The turbinates, of which the inferior is the largest and the only one which is an independent bone, are attached anteroposteriorly to the outer wall and serve to expose a large mucous surface to the air. The superior and middle turbinates are processes of the ethmoid which serve a similar purpose. The superior is the smaller and in some cases is divided posteriorly, a condition said by Voltolini to be normally present in negroes. The three meatus are situated each below the turbinate bone which bears the same respective name. About the middle third of the middle meatus is an oblong fissure which leads into the maxillary antrum, a cavity hollowed out of the body of the superior maxilla, measuring about 27 mm. in both its vertical and its anteroposterior diameters. Accessory openings into this cavity may sometimes exist posteriorly in the middle meatus. The frontal sinus is found in adult life between the two tables of the frontal bone immediately above the orbit, and communicates with the middle meatus anterior to the ostium maxillare through the infundibulum. Sometimes the sinuses on the two sides coalesce to form one cavity, sometimes they are separated by a bony partition. They are irregular in size, and may be quite unequal on the two sides of the same head. The sphenoid sinus is hollowed out of the body of the sphenoid bone, and may be divided by cellular partitions. It opens superiorly into the posterior ethmoid cells and superior meatus, and inferiorly by a foramen into the posterior nasal space. The ethmoid cells are not simply excavations of the interior of bones, but are composed of masses of cells separated by bony laminæ and divided by a partition into the anterior and the posterior cells; the former open into the middle, the latter into the superior meatus. The nasal fossæ

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and accessory sinuses, as well as the lacrimal duct which opens into the inferior meatus anteriorly, are lined by a continuous mucous membrane, except in the vestibule, where it is replaced by modified cutaneous tissue, furnished with a number of stiff hairs. The nerve-supply is from the branches of the ophthalmic and superior maxillary divisions of the fifth, branches from the sphenopalatine ganglion and from the olfactory nerve. Beneath the mucous membrane on the turbinate bones are several masses of erectile tissue, the turbinate bodies (Schwellkörper of Zuckerkandl), situated one over the inferior, one along the border of the middle, and one at the posterior extremity of each of the turbinate bones. They obtain their blood-supply from the deeper capillaries of the mucous membrane and of the periosteum.

The **functions of the nose** are four—the sense of smell, the modification of inspired air, resonance for the modulation of the voice, and combined secretion and excretion. The olfactory tract is located above the level of the upper third of the middle turbinate body, where the filaments of the olfactory nerve are abundantly distributed. Odoriferous particles are here dissolved in the serous secretion and occasion the impression on the nerve communicated as the sense of smell. Here the epithelium of the mucous membrane is non-ciliated, and a peculiar variety of tubular gland, known as Bowman's, is met with. Below this level is the respiratory tract, which includes the lower and middle meatus. The hairs, or vibrissæ, in the vestibule serve to filter the inspired air from the coarser dust. Such particles as escape this filtration adhere to the mucous membrane, which in this region is covered with ciliated epithelium. At the same time the air is warmed and charged with aqueous vapor, two important factors in the protection of the respiratory organs and the preservation of perfect health. The *timbre* of the voice depends upon the resonant character of the nasal cavity. The pharyngeal vault is a sounding-board ; the horizontal air-passages throw the tones forward, and any closure or diminished caliber of these passages will cause the voice to lose its carrying-power and quality. The secretions of the nasal mucous membrane lubricate its surface and that of the larynx and esophagus, and furnish the moisture taken up by the inspired air.

Cutaneous diseases of the nose are, as a rule, the same as those of other parts of the face. Sarcoma, epithelioma, and leprosy occasion extensive destruction of the nasal tissues, and need to be differentiated from lupus and syphilis. Though essentially a cutaneous disease, **lupus** sometimes primarily attacks the nasal mucous membrane and forms characteristic nodules which ulcerate with the production of redundant, jelly-like tissue, not prone to hemorrhage, and covered with flat, brownish crusts. Its progress is usually slow, but exceptionally very rapid. It may be distinguished from epithelioma by the dark color of its nodules, its pulpy feel, its slight tendency to bleed, the absence of a hard margin, and the presence of tubercle bacilli ; from syphilis, by its failure to respond to antisyphilitic treatment, and usually by its slow progress. It is a disease of youth, localized and spreading by infection. Tubercle bacilli are sparsely found in its tissue ; general tuberculosis has, in many cases, however, followed inoculations with lupus, thus establishing the near relationship of these diseases. The general health suffers, and the treatment must be primarily directed to its support. The pulpy mass of diseased tissue should be removed and caustics applied. Repeated operations are usually necessary.

Rhinoscleroma is a rare disease which causes extraordinary hardness of the nose. It develops slowly, occludes the nasal passages, and is characterized by the presence of a certain bacillus. Pawlowsky claims to have obtained good results from injections of rhinosclerin, but otherwise the disease has not been amenable to treatment.

Syphilis, when present in the nose as chancre, mucous patch, coryza, or other form of the secondary stage, is sometimes difficult to recognize, but is of less interest to the rhinologist than the tubercular syphilide and gumma of the tertiary stage. The syphilide appears as a dark crescentic patch, which may slowly progress without ulceration, or may rapidly break down and cause extensive destruction of the flesh and framework of the nose, leaving the nasal cavities exposed. A gumma may appear in any part of the nose, but most frequently is seen on one side of the septum, where it forms a prominence, which may be differentiated from that produced by a deviation of the septum by the lack of bony hardness and the absence of a corresponding concavity on the opposite side. It resembles also a sarcoma, but is amenable to antisyphilitic treatment. After a period of quiescence it breaks down and involves in its destruction the neighboring soft and bony

FIG. 48.—Small round-cell sarcoma (Weir).

tissues. A perforation of the bony septum may not cause deformity, but when the cartilaginous septum is involved the tip of the nose sinks in, and when the nasal bones are destroyed great disfigurement results from the sinking of the bridge of the nose. A gumma on the floor of the nasal fossa may result in a perforation into the mouth. Hereditary syphilis occurs in very young children as a purulent, offensive coryza; in older children as gummata and ulcerations of the mucous membrane, with destruction of the nasal framework. In these cases the prognosis is not good, but the strength of the patients may be maintained with tonics and cod-liver oil. In all forms of syphilis mercury and potassium iodid form our reliance. Local treatment is confined to the removal of crusts and sequestra and the maintenance of cleanliness.

Tuberculosis of the nose is rare, usually is associated with general or pulmonary tuberculosis, and generally occurs in the form of ulcers of the mucous membrane of the septum or floor, which tend to

spread, not to heal, and after cicatrization to recur. Less often it appears in the form of small, soft, friable, sessile tumors of irregular size and outline, which are easily caused to bleed. The diseased tissue may be curetted, excised, or cauterized with various agents, but a cure is extremely problematical.

Glanders is a rare, almost invariably fatal, disease in man, caused by infection from a diseased horse. Usually a short period of incubation is followed by a painful swelling in the nose, associated with lymphangitis, a cutaneous eruption, and severe systemic trouble. The nasal discharge is at first yellow and glairy, later bloody, thick, and offensive. Pyemic symptoms and death follow. When the disease runs a slower course an extensive destruction of both the soft and the bony parts of the nose takes place, as in very virulent cases of syphilitic ulceration. Life has been saved in but few cases of this nature. The local lesion should be kept clean and the patient's strength maintained in every possible way.

Inflammation of the nasal mucous membrane, called **rhinitis,** may be acute or chronic, and presents the phenomena of vasomotor disturbance. Acute rhinitis may be of reflex origin, and is symptomatic in certain diseases, but is usually due to taking cold. It is most frequently catarrhal, but is sometimes croupous, and in diphtheria diphtheritic.

In **acute catarrhal rhinitis** the mucous membrane is at first dry, then bathed with a clear, acrid fluid, followed by a turbid mucopurulent discharge. The distended blood-vessels cause a swollen condition of the mucous membrane, which occludes the respiratory tract and causes pain from pressure. Conjunctivitis, tonsillitis, pharyngitis, laryngitis, and bronchitis may accompany, precede, or follow the attack, which is frequently associated with fever. The duration, when due to a cold, is about a week. Coryza of neurotic origin, as in hay fever, recurs with a certain periodicity; the swelling of the turbinate bodies is non-inflammatory and due to a vasomotor paresis.

Treatment.—I have had good success in checking acute rhinitis by giving in its early stage the following tablet (Fraser's Influenza No. 2) every hour until the throat becomes dry, and then every three hours.

$$\text{R}. \quad \begin{array}{ll} \text{Camphor,} & \text{gr. } \frac{1}{4}; \\ \text{Atrop. sulph.,} & \text{gr. } \frac{1}{800}; \\ \text{Strych. arsen.,} & \text{gr. } \frac{1}{320}; \\ \text{Ipecac.,} & \text{gr. } \frac{1}{20}.\text{—M.} \end{array}$$

During the declining stage $\frac{1}{100}$ grain of strychnin arsenate every **two** hours is effective, and a very agreeable nasal spray, which will give considerable comfort, is—

$$\text{R}. \quad \begin{array}{ll} \text{Menthol,} & \text{gr. xv;} \\ \text{Spiritus camph.,} & \text{ʒj;} \\ \text{Aq. dest.,} & \text{q. s. ad ʒiij.} \end{array}$$

M. et filt. Sig. Nasal spray.

Under no circumstances should cocain be employed, for while it gives temporary relief, it prolongs the vasomotor paresis.

The persistent excitement of the turbinate bodies by repeated

attacks of acute rhinitis, irritant dusts or other causes, results in the loss of the contractile power of the tissue and permanent dilatation of the venous plexus, together with more or less hyperplastic metamorphosis, a condition known as **hypertrophic rhinitis.** A true hypertrophy is not frequently met with, while what may properly be termed erectile tumefactions are common. They may be distinguished from one another by the power of cocain to contract a dilated plexus and its inability to diminish an hypertrophy. In erectile dilatation anterior inspection reveals the swollen mucous membrane and turbinate bodies. Posteriorly, grayish, raspberry-like masses, due to an enormous increase of the vascular plexus, may be seen on the inferior and middle turbinates, blocking the posterior nares. The mass on the lower turbinate is the larger, and is the one to which alone treatment should be directed. At the anterior extremity of the middle turbinate the swollen tissue may press upon the septum, and sometimes a myxomatous change occurs with the production of a polypoid condition. Not only is the free passage of air through the nose interfered with by these conditions, but the normal secretion of fluid to moisten the inspired air and lubricate the passages is lessened, so that the pharynx, larynx, and trachea become dry and irritated, a frequent sensation as of dropping of mucus into the throat is occasioned, the sense of smell is frequently, and vocal resonance always, impaired. Pressure between the swollen mucous surfaces and the septum induces headache, asthenopia, and various nervous symptoms. Acute and chronic catarrhal otitis media is a frequent result of this form of rhinitis, and treatment of the latter is essential to a cure of the former. In a certain number of cases the ear disease may be cured by treatment directed to the nose alone.

Treatment.—Considerable temporary relief may be afforded by removing the adherent mucus by means of an alkaline solution, but for permanent benefit a reduction must be made in the size of the dilated venous plexus. A raspberry-like mass at the posterior extremity of the inferior turbinate is best removed with the snare, which should be very slowly tightened in order to avoid the profuse hemorrhage which occurs when the operation is performed too rapidly. In order to produce a cicatricial bandage which may mechanically restrain the excessive dilatation of the erectile structure, the cautery or chromic acid, or, better, monochloracetic acid, may be applied. Coffin recommends submucous injections of monochloracetic acid into the posterior dilatations by means of his needle. After these applications, or any nasal operation, the patient should be warned to keep away from any store, theater, railway train, or other place where the air is vitiated, as this will invite an attack of tonsillitis. As a further precaution against this result, the frequent use of an oleaginous antiseptic spray is advisable.

Many writers have assented to the theory that the hypertrophic forms the early stage of **atrophic rhinitis;** but I agree with Bosworth that the atrophic is an essentially distinct disease, which usually commences in childhood as a purulent rhinitis and is characterized by atrophy of all parts of the mucous membrane, the formation of extensive crusts, and the presence of a foul odor peculiar to itself. Rice reports a few cases caused by excessive cigarette-smoking, but such are very rare.

Treatment of atrophic rhinitis (ozena, cirrhotic rhinitis) is not satisfactory as regards a cure, but great alleviation may be obtained by keeping the mucous membrane carefully cleansed from all crusts and

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discharge by means of an alkaline antiseptic douche and the constant use of oleaginous sprays. The patient should be taught to remove the crusts by a cotton-wound applicator before douching.

Malignant tumors are rarely met with in the nose. Primary **carcinoma** particularly is uncommon, though secondary deposits may more frequently be found. The pain is usually less than in carcinoma elsewhere, but the acrid discharge, the ulcerated grumous mass, the swollen lymphatic glands, and the general cachexia render the diagnosis not difficult. In the early stage, before the development of the characteristic symptoms, the diagnosis may be made by a microscopic examination of a portion of the growth. In cases of cylindroma extirpation may perhaps be undertaken with some hope of success, but in all other cases a policy of non-interference is best.

A **sarcoma** is perhaps oftener, yet rarely, found in the nose. It appears as a red or bluish soft tumor, which causes considerable epistaxis, together with symptoms referable to pressure and obstruction of the nasal passages. Early and thorough removal of the growth should generally be practised; but as recurrence must be expected, and as the recurrent growth is apt to be more rapid in its development than its predecessor, interference with a sarcoma which is found to grow very slowly in an adult and does not mechanically produce serious symptoms demands consideration before operating.

The only **benign tumors** frequently found in the nose are **polypi**, which are largely composed of a gelatinous substance held in a thin stroma of connective tissue. In them may be found the characteristic cells of myxoma and varying proportions of glandular structure, which justifies their classification by some authors as adenomata, together with other adventitious features, such as cystic degeneration. They almost invariably spring from the mucous membrane in the immediate neighborhood of the middle turbinate bone, and are easily recognized as shining, bluish-gray, grape-pulp-like bodies of various size, movable and resilient when touched with a probe. The consideration of their *etiology* has given rise to two ingenious theories, neither of which can be claimed as proved. The older, advanced by Woakes, ascribes them to a degeneration of a portion of the middle turbinate bone, with replacement of the local mucous membrane by a myxomatous structure. The more recent theory, that of Bosworth, is that in some manner the transudation of serum through certain portions of the mucous membrane is interfered with, and that local distentions are thereby formed, which develop into polypi. These tumors have been found at all ages, but are met with chiefly between the ages of twenty and thirty, and more commonly in men than in women.

The only *treatment* is removal, which is best accomplished by means of the cold snare, placed well about the neck of the polyp to insure its complete ablation. The removal of a portion of the subjacent bone to prevent recurrence is an unnecessary procedure, but it is advisable to touch the stump with monochloracetic acid.

Very rarely there may be seen to spring from the mucous membrane an irregular, soft, purplish growth formed of a network of connective tissue supporting a mass of blood-vessels. Such a tumor is called an **angioma.** It causes nasal obstruction and frequent epistaxis, and may be removed in the same manner as a polyp, with no danger except that of hemorrhage, which is not great if the operation be done slowly.

Occasionally the papillæ normally present in the mucous membrane undergo hypertrophy and form small tumors, **papillomata,** which are of no serious importance. When they occur in the vestibule they may be ablated with the scissors or the cautery, but when in the nasal cavity proper the snare is the best instrument to use for their removal.

Fibromata are firm, irregularly rounded tumors of light color, covered with a vascular network, generally found in the upper part of the nasal cavity. They grow persistently and push aside the adjacent bones. They may invade the accessory sinuses or the orbit, with the production of exophthalmus, or press apart the nasal bones and cause facial disfigurement. Pain is not common, except as a result of pressure upon the adjacent tissues, while epistaxis is frequent and severe. The usual symptoms of nasal stenosis are present. Fortunately these tumors are not often met with. Removal should always be attempted, because, if allowed to remain, such a tumor will continue to grow and eventually destroy the patient's life by the invasion of vital parts or by copious hemorrhages. The galvanocautery or the snare may be used for this purpose; but the operation must be very carefully performed, as it is attended with danger of a great and even fatal hemorrhage.

Cystic tumors are removed in the same manner as polypi. The possibility of the occurrence of a meningocele, as described by Cruveilhier, should always be borne in mind.

Aside from the cartilaginous and bony outgrowths of the septum, **chondromata** and **osteomata** are of rare occurrence. They are of slow growth, are not difficult to recognize, and should be removed at as early a stage as possible.

A **foreign body** when present in the nose must have entered through the anterior or posterior nares, through the nasal walls, or have developed *in situ.* Cases of entrance by means of a penetrating wound through the nasal walls can be considered only as curiosities. Vomited matters may be driven forcibly through the posterior nares and lodged in the nose, and a postnasal plug, intentionally introduced, is occasionally forgotten and permitted to remain; but most foreign bodies are introduced through the nostrils, usually by children and lunatics, and lodge in the inferior meatus, where, if not visible, they may be felt with a probe. Sometimes a foreign body will cause no noticeable symptoms, but in many instances it will cause pain and annoyance, nasal stenosis, and a unilateral mucopurulent discharge. It should always be removed by means of an instrument suitable to the case—forceps, hook, loop, or snare; never by means of a stream of water. Sometimes it is necessary to divide the foreign body previous to its removal.

Occasionally a foreign body remains unnoticed in the nasal cavity, and the salts of the nasal secretion gather upon it to form a **rhinolith,** or nasal calculus. Rhinoliths have been found in which a nucleus could not be detected, though probably one at first existed and eventually disappeared. As a rhinolith increases in size it causes annoyance, pain, unilateral stenosis, and discharge. Pressure upon the neighboring parts may cause them to yield and produce facial disfigurement, or ulceration of the superjacent soft tissues may occur. Small rhinoliths are removed in the same manner as other foreign bodies. Large ones, if hard, may need to be crushed with a lithotrite, provided it is not possible to detach them and push them into the pharynx. A snare may be passed about a large rhinolith, and so it may be held until it can be divided with a small saw. Enormously large stones may require an external operation.

Some species of **diptera** occasionally lay their eggs in the nasal cavity, and the larvæ,

when hatched, attack the mucous membrane, penetrate into the accessory sinuses and into the tissues beyond, destroy the soft tissues and bones as well, cause extreme pain, and sometimes death. A treatment most highly recommended is to wash out all the cavities in which they may be found, with equal parts of chloroform and water.

The Removal of Adenoid Growths in the Pharynx.—The patient should be anesthetized with ether, chloroform, or bromid of ethyl, as the case is more or less severe. Bromid of ethyl will give but two to three minutes of unconsciousness.

Anesthesia being complete, and the child lying on a table in a good light, a tongue-depressor makes easy the introduction of O'Dwyer's gag. The head is now slightly raised on a pillow, and three bites are taken with a Löwenberg or Curtis forceps—one broad median, and one at an angle of forty degrees on either side, to free the fossæ of Rosenmüller, care being taken to go behind the Eustachian prominences. The head and shoulders of the patient may then be quickly turned over the side of the table, and the free hemorrhage allowed to flow from the corner of the mouth into a receptacle on the floor.

In this position, the patient's head held by an assistant, the Gottstein curet may be employed to remove the débris, care being taken to carry the ring to the summit of the pharyngeal vault.

A Bosworth snare with a large loop may advantageously be passed through both nostrils to complete the removal of the mass high up in the vault. Small pieces of ice fed into the nostrils will assist materially in checking the hemorrhage, which seldom persists.

Fractures of the nasal bones are of frequent occurrence as the result of external violence. Both nasal bones are almost invariably broken, while the septum is frequently, and the nasal process of the superior maxilla, the cribriform plate of the ethmoid, and one of the turbinate bones are more rarely involved in the fracture. Displacement of the fragments of the nasal bones causes depression of the nose, which is readily noticeable, if seen prior to the onset of the swelling, and, if not properly treated, afterward persists as a serious deformity. Crepitation can usually be detected, especially when the fracture is comminuted. Epistaxis is generally present and is sometimes profuse. Emphysema may result from blowing the nose. To reduce the fracture, a solution of cocain should be applied to the mucous membrane to check the hemorrhage and allow the painless introduction of a blunt instrument like a director, a strong probe, a Wagner's sound, or, better, Weir's forceps, to elevate the fragments. If the septum is broken or the nasal cartilages are separated, the fragments must be maintained in position by means of plugs of ivory, cork, iodoform gauze, or other material; but when the septum is intact the fragments of the nasal bones will often retain their proper positions after replacement, or need only the external support of adhesive plaster or compresses. In compound fractures the lacerated surfaces should be thoroughly cleansed and rendered aseptic, the bony fragments reduced, the soft parts reunited, and an antiseptic protective dressing applied. The closure of wounds of the nose, whether incised or lacerated, requires very nice approximation of the integumental edges, and sometimes a support afforded by wire sutures is needed. Punctured wounds should be searched for a foreign body, which, if found, should be removed, and

the wound treated in the same manner as punctured wounds elsewhere on the body.

The repair of deformities which are due to the destruction of the whole or a portion of the nose by disease or accident, as well as those due to sinking of the bridge and the undue enlargement of the tip, is accomplished by operative measures grouped under the name rhinoplasty. It has been too frequently the case in these operations that improvement of the outward appearance has been the sole object, with no reference to the maintenance of the functions of the organ. When a nose has been largely or completely destroyed, it has been rebuilt by means of flaps taken from the forehead, the arm, the hand, or elsewhere, but the organs thus formed are less comely and less useful than properly colored artificial noses made of metal. When a portion of the soft parts of the nose has been destroyed and the bony

FIG. 49.—Weir's case of lengthening nose and filling gap by cheek-flaps.

FIG. 50.—Result of Weir's case of lengthening the nose by flaps taken from the cheek.

framework is sufficiently intact to preserve the respiratory function, it may be repaired to advantage by means of integumental flaps taken from the neighboring or from distant tissues. The form of the nose is exceedingly variable. Family and national characteristics are transmitted through many generations, but certain forms are considered deformities and have sometimes been operated upon for cosmetic reasons, while others look for the relief of a nasal stenosis. A common characteristic of these cases is a *lack of symmetry between the bridge and the tip.* In the most marked cases of sunken bridge the cheeks are united by a level surface in the midst of which the tip projects in a somewhat pyramidal form, while the common pug nose is the least important of this class. The opposite condition, that of *disproportionate development of the bridge*, is occasionally seen, but has seldom called for operation.

Keen has lately reported a case in which he drilled, then fractured the nasal bones, and

fastened the fragments in such a manner that the patient recovered from the operation with a straight nose. Figs. 51, 52 represent a case of Weir's in which a combined bony and cartilaginous exaggeration of size existed, the deformity being removed without appreciable scar.

FIG. 51.—Case of a large nose operated upon by Weir to relieve melancholia.

FIG. 52.—Case of large nose (after operation).

When the bridge is sunk to the level of the face, any attempt to elevate the nasal bones or their remains is usually attended with great difficulty, and if the respiratory function is performed properly, the use of a false nose is to be recommended rather than a plastic operation. If, however, nasal stenosis has been caused by the sinking in of the tissues, these must be elevated and maintained in position in such a manner as seems best suited to the individual case.

In cases of sunken or deflected nasal bones Weir recommends, first, that a bevelled incision be made at the junction of the ossa nasi and the superior maxillæ, and the bones loosened at their attachments by means of a graver's chisel. The opposite bone may be infrequently loosened by a prying motion with the chisel, assisted by pressure with the thumb, without incision on the opposite side. In cases of more extensive injury and flattening, it may be necessary to make an incision in the median line and separate the nasal bones from one another. The sunken bridge can then be raised and held *in situ* by transfixion with a pin clamped at either end by split shot, a small pad of iodoform gauze or a cork plate being interposed between the shot and the nose to avoid pressure. The bevelled incision is a suggestion of Packard, of Philadelphia, to prevent scarring, the cut being made obliquely, instead of at right angles to the surface. In case there is objection to a surface incision, the chisel may be operated from inside; but thanks to the bevelled cut, a resulting cicatrix that is visible is rare, provided thorough antiseptic precautions are taken. After operations of this nature the bones should, if possible, be made to conform to the required position without the aid of external pressure or strapping. The results are much better and more satisfactory if no internal plugs are left in the nostrils to retain secretion and act as foreign bodies.

Angular deformities or **bony humps** on the nose may be removed by making an incision on either side and reducing the bony deformity by the chisel; or the method of Roe, of Rochester, may be employed, which consists of entering the nose from within, and, after making an incision at the junction of the nasal bones and lateral cartilages, elevating the soft tissues and chipping away the nasal bones, care being exercised to avoid puncture of the thin skin over the bridge, which must be elevated from either side with the greatest care.[1] In general, other operations upon the nasal bones are best performed from without.

[1] *N. Y. Med. Record*, July 18, 1891.

It is frequently possible, with a single bevelled incision on one side, to free both nasal bones from their attachments by penetrating the bony septum and carrying the chisel to the opposite nasal bone, thus effecting a sufficient solution of continuity to reconstruct and remodel a badly twisted and deformed nose, and that without the use of external or internal splints.

FIG. 53.—Angular deformity of the nose.

FIG. 54.—Result after removal of the bony hump.

FIG. 55.—Deformity due to congenital syphilis. Insertion of platinum support (Weir).

FIG. 56.—Result after insertion of platinum support (Weir).

C. Martin of Lyons described an artificial bridge made of platinum, which was so favorably endorsed by Ollier[1] that Weir made use of it in several of his cases for the *relief of depression* of the nose caused by syphilis, with entire loss of the septum (Fig. 55).

[1] *Rev. de Chirurgie,* 1890, p. 828.

The operation consists [1] of doing a Rouge operation, involving an incision in the gingivo-labial fold, extending from the first molar tooth to that of the opposite side, the lip being

FIG. 57.—J. Solis-Cohen's saddle.

FIG. 58.—Weir's platinum bridge.
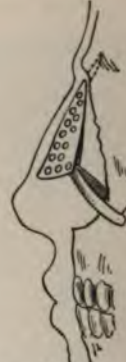
FIG. 59.—Martin's artificial bridge.

strongly drawn up over the face and the parts dissected back until the nasal fossæ are exposed. The septum is then divided so that the nose may be turned back sufficiently for the introduction of the artificial bridge. The lower legs should be inserted in drilled holes in the superior maxillæ high enough up so that the alæ may not be interfered with in their muscular expansions and contractions. After the solid implanting of the upper and lower legs in the maxillæ the face is drawn down, and the incision unites in a day or two without external evidence of its existence. More recently Weir used a platinum plate, elliptical in shape, when the bony parts were not so much destroyed and the end of the nose was strong enough to need no immediate support.

J. Solis-Cohen of Philadelphia has further modified this appliance by perforating the plate which forms the artificial bridge, in order to allow granulation-tissue to penetrate the holes and, if possible, to guard better against the atrophy that results in the skin immediately over the simple plate. The instrument of Solis-Cohen is a kite-shaped, perforated platinized gold plate, with a pin soldered to its more acute extremity, which is driven into an interstice in the frontal or nasal bony junction. The legs consist of platinized gold springs supplied with pegs which are sprung into holes bored in the maxilla of either side, thus affording a very rigid support to the remodelled nose. When the depression of but one bone or but a portion of the bony bridge of the nose is to be remedied, Weir has recently introduced oval, boat-shaped pieces of celluloid, which are worked into position after making a bevelled incision in the side of the nose and elevating

FIG. 60.—Hypertrophy of the nose (Weir).

the tissue. The wound is then immediately closed and healing attempted by first intention. A bridge of celluloid is better than platinum, in that the tissues surrounding it are not so

[1] *N. Y. Med. Journal,* 1892, p. 451.

prone to atrophic changes. At best, these operations offer but temporary improvement. Experience has demonstrated that tissue-changes progress slowly where the integument is stretched over an artificial bridge, and but few cases resist the effects of time. A periosteal membrane would seem essential to prevent atrophic changes in the integument.

Pug nose has received more attention since John O. Roe of Rochester explained its etiology and pathology, and suggested operative treatment. Heredity is an important factor, but traumatism and disease are frequently the predisposing causes by the production of nasal stenosis which interferes with the circulation, induces vascular distention and hypertrophy at the end of the nose, resulting in a permanent enlargement of the tip. Sometimes a lack of development occasions a sunken bridge, while the tip develops normally, or frequently we find a combination of both conditions. Dr. Roe's method of correcting this deformity is to render the nose symmetrical by removing from the tip the tissue which is in excess, so as to render it proportionate with the bridge. The vestibule is cocainized and brightly illuminated with a good light. If the mucous membrane is not too firmly adherent,

FIG. 61.—Operation for pug nose.   FIG. 62.—Result of Roe's operation.

it should be dissected back, to be replaced after the operation. The end of the nose is turned upward and backward, and held with a retractor by an assistant while enough of the superfluous tissue is dissected out to allow the nose to conform to the desired shape. The judgment of the operator is his only guide as to the quantity to be removed, and great care is needed not to remove too much, not to remove it unevenly, and not to wound the skin, lest the tip be made too small, or a scar or indentation be produced. In some cases no after-treatment is required, while in others a splint is needed to keep the nose in proper shape during the healing process. A large tip is not always due to excess of tissue, but may be caused by a malformation of the cartilages, which bulge upward with a corresponding concavity inside. These may be cut in various places in order to destroy their elasticity; the nose is then adjusted to its proper form, and retained during healing by means of an external splint combined with tubes of proper size and shape placed in the nostrils.

Fracture of the vomer is rare and not likely to be recognized, as no displacement is occasioned. In comminuted fractures of the nasal bones the perpendicular plate of the ethmoid is sometimes involved, but the more commonly involved portion of the septum is the *cartilage*. In children the cartilage is frequently dislocated, an accident which it is difficult to remedy, because, in spite of treatment, the dislocation and the accompanying twist of the nose is apt to recur. Fracture of the cartilage occurs in adults. The dislocated or fractured cartilage may be set, and the fragments held in place by a hard-rubber tube made to fit the nostril.

Bosworth has reported two cases of *dislocation of the columnar cartilage*, ascribed to pressure of the thumb in using the handkerchief. In both cases the cartilage was reduced with good results.

Deviations of the septum may be due to direct injury, improper mode of lying during infancy, congenital deformity or unequal cranial development, and may be bony, cartilaginous, or both. They have been classified by the writer in the following manner, as a convenient method in which to keep records:

 a. Vertical (V);
 b. Horizontal (H);
 c. Oblique, ascending and descending (O. A., O. D.);
 d. Sigmoidal (S);
 e. Pyramidal (P).

The vertical deflection has an anterior and a posterior plane, with the line of the ridge or intersection perpendicular to the floor of the nasal cavity.

The horizontal deflection consists of two planes or faces, with the ridge or intersection parallel with the floor of the nasal cavity.

The oblique ascending consists of two planes or faces, with the ridge or intersection rising obliquely and backward, usually corresponding with the line made by the articulation of the vomer with the cartilage of the septum.

The oblique descending ridge will make either an acute or a right angle with this line.

The sigmoidal is represented by a right horizontal deflection in the middle meatus, and a left horizontal deflection into the inferior meatus of the opposite side, or *vice versâ*. Sigmoidal deflections may be horizontal or vertical; in the latter case the deflections are anterior in one and posterior on the opposite side.

The pyramidal deflection presents three or more planes, whose apex points either to the right or left.

Record of an operation may be quickly and conveniently made thus:

 R. H. D. I.M. ⅔ in. Trephine; or
 L. P. D. M.M. Saw;

meaning in the first case, an operation with the trephine on a right horizontal deflection which caused stenosis of the inferior meatus and extended for ⅔ of an inch; and in the second case, an operation with the nasal saw on a left pyramidal deflection projecting into the middle meatus.

The deflections most frequently met with are cartilaginous, horizontal, or oblique ascending, in the anterior portion of the nasal cavity. Next in frequency are more extensive ones of the same varieties with bone posteriorly, and then follow in order the pyramidal, vertical, sigmoidal, and oblique descending. A horizontal deflection which involves the posterior border of the vomer, as well as a purely bony deflection, is rarely seen.

Many people pass through life in comparative comfort with deflected septa, and the presence of a deviation alone is not sufficient warrant for an operation. There must also be present some reflex or direct trouble which may properly be ascribed to intranasal pressure or stenosis, such as asthma, headache, asthenopia, anemia, or inflammation of the other respiratory organs or of the middle ear. An operation should be avoided in cases of hemophilia, when there is less than 50 per cent. of oxyhemaglobin in the blood, and when the patient has gout or secondary syphilis. In cases of diabetes or renal disease the condition of the patient as regards these complications must determine whether an operation is advisable or not.

Quelmaltz in 1750 advocated digital manipulation for the correction of deviations of the septum, and the first suggestion as to operative treatment is attributed to Chassaignac in 1851. Attempts to remove them by means of knives and scissors are attended with much hemorrhage and accomplish little. Approach through an incision involving the integument is an unnecessarily formidable operation. Punches and fraction-forceps have been employed to crush the deviated septum, which is then held in place by means of nasal plugs of ivory, cork, or other material, but this is not a very reliable method. We are indebted to Goodwillie for the revolving knives known by his name, and for the application of the surgical engine to nasal work; to Jarvis for the suggestion to remove cartilaginous deviations by means of transfixion and the snare; and to Bosworth for popularizing the use of the saw. Of these, the best are the very thin, straight, probe-pointed saws which cut either up or down. Preferably one operates from below upward to avoid obscuration of the field by the hemorrhage. I prefer my own nasal trephine with the electric motor to any other instrument, for several reasons. It can be used in many cases where the ridges appear as a thickening to which the saw could with difficulty be applied; the operation is done more quickly and with less nervous shock to the patient than by any other method; the tissues beyond the deviation are not lacerated, a perfectly clean bore is made without annoyance from hemorrhage; an exploratory channel can be made when the posterior face of the deviated septum is not visible; the bone may be removed with less

motive power and at the same time with greater accuracy than in any other manner. Before the operation the nasal cavity should be cleansed with an antiseptic wash; then a thin layer of cotton wet with a 10 per cent. solution of cocain should be placed over the ridge so that every part of the tissue to be removed is covered, and allowed to remain for ten minutes. It should now be removed, and the nasal cavity again freely bathed with an antiseptic solution. The depth of the ridge should be determined with a flat probe and the direction of the floor of the cavity fixed in the mind of the operator, who should with his left hand hold the speculum, and at the same time steady the patient's head, and with his right introduce the trephine, guided by the groove in the lower lip of the speculum. The trephine may vary in size from $\frac{1}{32}$ to $\frac{3}{8}$ inch in diameter. The cut is circular and leaves a concave surface, but an operator with sufficient skill may cause it to leave as flat a surface as a saw. When the perforation is complete the core may remain within the cylinder of the trephine and be removed with it, otherwise it can be removed with a snare. It is not wise to use a trephine with a lateral opening. The aperture for cleansing purposes should be placed behind the shoulder to prevent all possible jumping. After the bleeding has ceased the clot should be removed from the vestibule to allow air to pass through the nostril, but washing should be avoided in order to preserve the clot over the wound. An insufflation of aristol powder is advisable. No plug or foreign body should be allowed to remain if avoidable. The nose should not be blown for at least eight hours, and then gently. An antiseptic spray may be used on the following day, but much fussing is apt to do harm.

Cartilaginous and bony **spurs of the septum** are best removed in the same manner. The use of the thermocautery for the destruction of these or other morbid conditions of the septal tissues should be unsparingly condemned, as the resulting cicatrices not only prevent the reproduction of the normal epithelial structures, but also, by promoting scab-formations within the nostril, cause great annoyance and often serious nervous reflexes which render the condition of the patient intolerable. Electrolysis is an unsurgical and unscientific procedure when applied to this condition.

FIG. 63.—Straight scissors.

FIG. 64.—Angular scissors.

FIG. 65.—Compressing-forceps.

Asch's Operation.—Cases in which the septum is not thickened, but bent so that a stenosis is produced by contact with the outer wall, sometimes require a more radical operation for their relief. In these conditions the operation devised by Asch, a modification of Adams's, is

to be recommended. This consists in making a crucial incision by means of especially devised scissor-forceps (Figs. 63–65).

The patient, after having the nostrils sprayed with an antiseptic solution, is thoroughly etherized, and the head is drawn over the edge of the operating-table, in order to prevent the blood running into the larynx. The elevator is then introduced into the stenosed nostril, and any adhesions that may exist are thoroughly broken up; if the adhesions should be bony, as sometimes happens, it will be necessary to use a gouge. If any synechiæ exist at the orifice of the nostril, it is better to divide them some days before the operation. The cutting-forceps are then introduced into the nostril, the blunt blade in the stenosed side, and an incision is made horizontally, directly over the greater convexity of the deviation. It is sometimes not easy to make this incision, but the instrument should not be withdrawn nor moved from its line of incision until the yielding sound, indicating the division of the cartilage, is perceived. The instrument is then withdrawn and reintroduced, this time in a direction at right angles to the former, and a cut is made as nearly as possible across the center of the first incision and at right angles to it, care being taken, in cases where the deviation is extreme, that the narrow blade passes across the first cut, and not through it. The operator then pushes his finger through the passage thus made, into the opposite nostril, breaking down in this way, at their bases, the segments made by the crucial incision; on doing this properly the success of the operation depends, for in this way the resiliency of the cartilage is destroyed and the return of the deformity prevented. The compressing-forceps are then introduced and a further straightening of the whole septum effected. The hemorrhage, which is sometimes pretty severe, is checked by a spray of ice-cold Dobell's solution, and a properly fitted nasal tube, Asch's or Mayer's, according to the requirements of the case, is introduced into the previously stenosed side, a smaller tube being introduced into the other nostril. This usually checks all hemorrhage, and the patient is returned to his bed, with direction to have the nostrils sprayed out with cold Dobell's solution every half-hour for twenty-four hours. At the end of this time the tube is removed from the non-stenosed side and not replaced. At the end of forty-eight hours the other tube is removed, thoroughly cleansed, and replaced, the nostrils having been well sprayed out. This removal and cleansing must be repeated daily for from four to six weeks. The patient

FIG. 66.—Mayer's hollow splint.   FIG. 67.—Asch's hollow splint.

must remain in bed for four days. At the end of this time he will be able to take out and replace the tube himself, but he must be instructed to cleanse it thoroughly, and wash it in carbolized water before replacing. It sometimes happens, after the tube has been permanently removed, that some irregularities are observed in the septum; but these are usually absorbed in time, or, if they prove refractory, are easily removed by a touch of the galvano-cautery or electrotrephine.

In an experience of over 200 cases Asch has observed no unpleasant result. It must be borne in mind that it is absolutely necessary that all instruments used in the operation be perfectly sterilized, and that the parts operated upon should be kept in as aseptic a condition as possible for four days subsequently.

A more recent operation for the reduction of a vertical or horizontal deflection of the septum where the concavity intrudes itself beyond the median line into the occluded nostril is that of Watson of Philadelphia, which consists of sawing upward parallel with, or in, the median line, to include the entire deflection, causing it to hang as a flap, with the hinge corresponding to that portion of the septum joining the upper ends of the resulting U-shaped cut. This flap is next pushed, by means of the finger on its convexity, through the opening in the septum into the opposite side and carried upward until the resiliency of the hinge is entirely overcome. The flap now remains in the previously free fossa and the mucous membrane unites with remarkable rapidity. After the flap has been pushed through, any posterior narrowing beyond the fenestration in the stenosed side may be corrected by fracturing the vomer with Weir's septal forceps. An Allen's or Berens' cork-tube may be dropped in the stenosed side for forty-eight hours, should it be necessary; but it must cause no pressure, and after that time it must be removed daily to be thoroughly cleansed; the nostril meanwhile should be sprayed with an antiseptic alkaline solution. In some cases I have

found it of advantage to modify this operation by trephining through the septum two orifices corresponding to the ends of the U, and by using one of my probe-pointed saws to make the posterior cut first, operating through the free side, sawing downward, the point of the saw playing in the opposite meatus posterior to the occlusion. This cut is made crescentic at the bottom to meet the descending cut made anteriorly through the occluded naris, the point of the saw this time playing in the free nostril. By this manner of operating, each cut may be made to conform more nearly to the vertical median line, and I think a better result is possible in extensive operations on account of the view we get of the posterior incision while sawing. Watson's operation certainly gives very flattering results, and so far is in advance of any other yet suggested for the correction of this especial kind of deformity.

Inflammation of the Accessory Sinuses.—It is probably a frequent occurrence during an attack of acute rhinitis that the mucous membrane lining one or more of the accessory sinuses becomes the seat of an acute inflammatory process similar to that of the nasal mucous membrane, but as long as the natural outlets of the sinuses remain open the excess of secretion escapes into the nose, and no special symptoms are presented, aside from a feeling of heaviness and sometimes a dull pain, which are difficult to distinguish from the sensations produced by the rhinitis itself. This condition is one of which we know little or nothing, and which seldom if ever calls for treatment beyond that given for acute rhinitis. Some of these cases become purulent, and gentle irrigation with a warm saline solution may be of service.

When the natural outlet of a sinus becomes occluded, the pent-up contents are apt to become purulent, and the resulting pressure causes great pain. This condition demands immediate evacuation and irrigation of the cavity. Prompt recovery usually follows; and then measures should be taken to restore the patency of the normal outlet. A chronic empyema may result from such an acute inflammation, or it may be caused by localized disease or injury, and become in itself the excitant of untoward processes, such as polypoid degeneration of the mucous membrane, caries, and necrosis of the bony walls. Atrophic rhinitis sometimes invades the sinuses and results in the accumulation of putrid débris and degenerative changes in the tissues, conditions which require irrigation, curetting, and drainage. The manifestations of syphilis and tuberculosis, as well as tumors and foreign bodies, are occasionally met with in the sinuses, and call for appropriate treatment. A unilateral nasal discharge in an adult is usually indicative of sinusitis; in a child, of a foreign body in the nose.

Empyema of the Maxillary Sinus.—The antrum of Highmore, or maxillary sinus, is the sinus most exposed to injury and the most frequently subject to inflammation. It is situated on a lower level than the frontal and ethmoid sinuses, and its opening is so situated with reference to their outlets that the products of inflammation in them may flow into this sinus, which may then serve as a pus-reservoir. The opening is also so situated in the middle meatus that it is liable to be occluded by a swollen turbinate body or a polyp. Finally, a very large proportion, if not the majority, as many claim, of cases of inflammation in the maxillary sinus are dependent upon the presence of carious teeth. The inflammation usually commences in a catarrhal form; the mucous membrane becomes hyperemic and swollen, later edematous. The blood-vessels give way, causing minute hemorrhages, and as the

swollen mucous membrane begins to subside, a more or less profuse secretion of muco-pus streaked with blood appears, which slowly changes its characteristics into those of pure pus (empyema). When the mouth of the sinus is open, there may be a feeling of oppression and fulness, with a dull pain in the infra-orbital region and a unilateral nasal discharge. If the attack is coincident with an attack of acute rhinitis, no additional treatment is needed until the subsidence of the latter; but if there is no coincidental acute rhinitis, or if the sinusitis persists after the subsidence of the rhinitis, the teeth must be examined, and if possible the cause of the trouble determined. If a carious tooth appears to be the cause, it should be extracted and an opening made upward through the socket through which to irrigate the antrum; but if the trouble cannot properly be charged to this cause, the antrum should be irrigated through its natural opening with a bland alkaline solution. This is frequently sufficient to determine resolution, after which any intranasal trouble which may predispose to a recurrence should be treated. If during an acute attack of inflammation of the antrum the mouth of the sinus becomes obstructed and much pain is caused by the resulting pressure, immediate evacuation of the pent-up contents is demanded, either through the natural opening or through an artificial one in the inferior meatus, or by the removal of a tooth and trephining or drilling into the cavity. In some cases an acute attack of inflammation of the antrum passes into a chronic stage, characterized by a more or less continuous discharge of pus into the nose, which is apt to become decomposed after retention for a day or two and to have a fetid odor, which may readily be distinguished from that of ozena by the fact that it is noticeable to the patient, more so at times than at others. When this is of dental origin the offending tooth should be removed, an opening drilled upward through the socket, the sinus thoroughly cleansed, and permanent drainage secured by means of a tube closed with a small stopper during mastication, or by a graduated hard-rubber plug with a knob-end which may be removed in order to introduce the tip of the syringe-pipe, which is made of the same caliber as the plug employed. In syringing, a soft-rubber bulb-syringe should be used, the head tilted forward, and the fluid by a gentle continuous stream allowed to flow out of the nose. A half-pint of warm antiseptic fluid may be used as frequently as pus forms.

In the absence of a diseased tooth an opening should be made through the malar ridge, as practised by Myles, or in the canine fossa, large enough to admit the finger; but care must be taken not to extend the fenestration too far in a vertical direction, lest it cause deformity and injure the infra-orbital nerve or its accompanying vessels. Through this aperture the antrum can be thoroughly explored and any necessary operation readily undertaken.

In cases where simple evacuation of the contents and syringing for a longer or shorter period, as well as a packing of iodoform gauze through the orifice in the canine fossa, fail to effect a cure of the empyema, we must have recourse to a free curetting of the walls to remove a possible polypoid degeneration or caries within the cavity of the sinus.

The *diagnosis* of empyema of the antrum is not always easily deter-

mined. In an adult a unilateral purulent nasal discharge is almost pathognomonic of purulent inflammation of one or more of the accessory sinuses, and, if after cleansing the nasal fossa the pus can be seen to reappear beneath the middle turbinate at the ostium maxillare, particularly if there is a feeling of heaviness or pain in the infra-orbital region, the presence of an empyema in the antrum may be considered as determined. When the escape of pus from the mouth of the sinus cannot be distinctly made out, transillumination is often of great value by showing the presence or absence of an umbra in the infra-orbital region. Its presence, associated with symptoms of sinusitis, renders the diagnosis of antrum disease very probable. It must, however, be remembered that transillumination by the electric light held in the

FIG. 68.—*a*, Posterior ethmoid cells; *b*, anterior ethmoid cells having no communication with the posterior cells; *c*, sphenoid sinus and its communication with the posterior ethmoid cells; *d*, frontal sinus; *e*, infundibulum communicating with the middle meatus; *f*, maxillary sinus; *g*, nasal canal communicating with the lacrimal sac (Hirschfeld).

mouth has proved a great disappointment as an aid to diagnosis, as the umbra is not always visible, and the orbit is often illuminated on the affected side, though the antrum may be entirely occupied by pus or even an osteoma. It must be borne in mind that unless a distinct umbra is shown by transillumination the diagnosis must be confirmed by other means. All doubt may be removed in any case by puncture through the wall in either the middle or inferior meatus or the canine fossa, and the presence or absence of pus determined.

Acute catarrhal inflammation of the frontal sinus may occur at any stage of an acute rhinitis, and is characterized by intense frontal pain, tenderness under the superciliary ridge, conjunctival congestion, some photophobia, and occasionally a slight edema around the eyes.

If the inflammation becomes purulent, these symptoms become aggravated and pus appears in the anterior part of the middle meatus. All of the symptoms, after persisting for several days, may pass off suddenly with an abundant flow of mucus or pus into the nose. The *treatment* is the same as recommended for acute rhinitis, with the addition of douches of hot water. Dover's powder is sometimes very useful, and occasionally a Turkish or Russian bath is beneficial; but after the latter, any exposure to cold must be avoided for a considerable time. After recovery, all nasal obstructions should be cleared away as a prophylactic measure against recurrence.

Chronic Empyema of the Frontal Sinus.—Chronic empyema, less frequently met with in the frontal sinus than in the antrum, originates in attacks of acute inflammation, and is generally dependent on the existence of nasal obstruction. It is characterized by local pain and tenderness, and sometimes bulging of the walls of the sinus. The pain is usually dull, sometimes severe, worse during damp weather and during acute rhinitis. Pus may be found in the front part of the middle meatus, constantly in small quantities, or occasionally in large. The patients become both mentally and physically depressed and apathetic. When associated with other trouble the *diagnosis* of empyema of the frontal sinus is by no means easy, but when it is alone it may be reached by exclusion. If pus appears in the front part of the middle meatus, associated with symptoms of sinusitis and with no intranasal condition capable of producing a purulent discharge, and if there is no disease of the antrum and no bare bone to be felt in the ethmoid, it may confidently be said to come from the frontal sinus.

Treatment.—Opening the frontal sinus from within the nose is not advisable, and often impracticable, though sometimes when an external incision is refused, we may obtain good results by removing with scissors or forceps the anterior portion of the middle turbinate bone, and succeed in entering the excretory duct of the sinus, the infundibulum, thus evacuating its pent-up contents. A stream of warm boric-acid water directed toward the opening will frequently give relief. It is frequently necessary to enter through an incision above and parallel to the superciliary ridge or made vertically between the superciliary ridges a little nearer the one over the involved sinus. This incision is made down to the bone, which is perforated with chisel and bone-forceps so as to permit exploration, and, if necessary, curettage of the cavity. A drainage-tube may then be passed down through the infundibulum into the nose by Luc's method, and the external wound closed and dressed antiseptically to secure primary union, the drainage-tube being removed afterward through the nose; or drainage is secured through the external wound for a few days, or the cavity may be packed with gauze and the wound kept open. The first method leaves a very slight scar, and is preferable in suitable cases. After operation the sinus should be frequently irrigated with a warm boric-acid solution.

As the full development of the frontal sinus does not take place until several years after puberty, the above-mentioned procedures are not indicated in young persons. Under the age of twenty, especially when there exists inflammation in the cancellous structure of the bone, Myles recommends that the external incision be made below and parallel to the inner border of the superciliary ridge. Care must be exercised in this operation to avoid the insertion of the superior oblique muscle, and it must be remembered that wounding the

annular artery gives rise to copious hemorrhage. After making either of these incisions the sinus is entered, by means of the mallet and chisel or gouge, in such manner that the sinus may be fully explored. In conjunction with either of the above methods, it is well to remove the anterior end of the middle turbinate bone and explore the infundibulum. In no nasal operation is more caution required in manipulating, for we must recognize the extreme anatomical variations which are found in this sinus, both as regards size, position, and thickness of the walls. It is very easy to pass a probe through the ethmoid cells into the brain cavity, thinking we are in the infundibulum ; and if the electric trephine is used either from within or without, we must be positive as to the relationship of the parts, else we may do irreparable damage.

Ethmoid Disease.—Acute catarrhal ethmoiditis probably frequently occurs, but little is known about it, as it accompanies and passes away with acute rhinitis and calls for no special treatment. But when the secretions are wholly or partially retained, the inflammation assumes a purulent character and soon attacks the delicate bony laminæ which separate the ethmoid cells.

Bosworth and Wright both assert that this is the most frequent form of purulent inflammation of the accessory sinuses. It may or may not be associated with pain and tenderness at the root of the nose ; but there is no satisfactory way of distinguishing it from inflammation of the frontal sinus except by the detection with a probe of bare bone in the ethmoid. The *treatment* consists in the removal of all nasal obstruction, including the anterior end of the middle turbinate, to better approach the ethmoid cells. It is advisable then to scoop away the granulations and diseased bone, and afterward to keep the cavity clean by syringing with a bland antiseptic solution.

Sphenoid Disease.—When pus is seen to come from the superior meatus and flow over the posterior part of the middle turbinate, it may arise from the posterior ethmoid cells or from the sphenoidal sinus. Both of these are apt to be involved at the same time ; their mouths are close together, and a differential diagnosis is very difficult. If the pus can be constantly seen in the rhinoscopic mirror to trickle down from the top of the posterior nares along the septum or lateral wall of the pharynx, the sphenoidal sinus is probably involved. The secretion, when retained, may cause destruction of the bony walls and break into the orbit. Inflammation of the sphenoidal sinus is seldom recognized by itself, but is usually diagnosed in the course of the treatment of inflammation of other sinuses.

Treatment.—The natural orifice may be enlarged with a probe, and a syringe with a proper cannula introduced for the purpose of cleansing. The treatment of these cases is apt to be very tedious, and it is well to accustom the patient to syringe his own sinus, which frequently has to be done many times a day. A case is under my care to-day whose sphenoidal sinus I trephined four years ago, giving great relief; but it is necessary to syringe the sinus every few hours day and night to insure absolute comfort. Pus contained in the sphenoid sinus and posterior ethmoid cells is apt to break into the orbit and compress the vessels and nerves of the eye, disturbing vision and producing exophthalmos. The only means we have of relieving this condition is by the long-shaft trephine, the penetration being made as near to the natural orifice as possible. The middle turbinate bone must frequently be removed to secure access to the same. At best, the results are unsatisfactory and each individual case demands a particular treatment.

Lermoyez and Dundas Grant have differentiated suppuration in the various sinuses of the nose as follows :

7

SIGNS OF PURULENT SINUSITIS.

Presumptive :
  (*a*) Unilateral pus.
  (*b*) Pain relieved by evacuation.
  (*c*) Subjective fetor.
  (*d*) Polypi.
Probable :
  (*a*) Pus at orifice influenced by attitude.
  (*b*) Opacity on transillumination.
Certain :
  (*a*) Irrigation.
  (*b*) Puncture and aspiration.
  (*c*) Puncture and irrigation.
  (*d*) Puncture and transsufflation.

SITE OF SINUSAL SUPPURATION.

Pus in Middle Meatus :
  Anterior group :
    Antrum.
    Anterior ethmoidal cells.
    Frontal sinus.
Pus in Olfactory Slit :
  Posterior group :
    Sphenoidal sinus.
    Posterior ethmoidal cells.

ANTERIOR GROUP.

SIGNS OF SUPPURATION OF ANTRUM.

Presumptive :
  (*a*) Unilateral pus.
  (*b*) Intermittence.
  (*c*) Infra-orbital pain.
  (*d*) Subjective fetor.
  (*e*) Upper molar caries.
  (*f*) Pus in middle meatus.
  (*g*) Mucous polypi.
  (*h*) Lateral swelling.
Probable :
  (*a*) Return on bending forward.
  (*b*) Opacity on transillumination.
Certain :
  (*a*) Puncture and transsufflation,
  (*b*) Puncture and irrigation.
  (*c*) Puncture and aspiration :
       (1) Inferior meatus.
       (2) Alveolus.
       (3) Canine fossa.
       (4) Middle meatus.
  (*d*) Catheterization, inflation, irrigation.

SIGNS OF SUPPURATION OF FRONTAL
SINUSES.

Presumptive :
  (*a*) Continuity of discharge.
  (*b*) Seat of pain.
       (1) Spontaneous.
       (2) On pressure.
Probable :
  (*a*) No return on bending forward.
  (*b*) Return after antral irrigation.
  (*c*) Pus on tampon in hiatus.
  (*d*) Transillumination.
       Antrum—negative.
       Frontal—positive.
Certain :
  (*a*) Catheter.
       Inflation.
       Irrigation.
  (*b*) Operation.

SIGNS OF SUPPURATION OF ANTERIOR ETHMOIDAL CELLS.

Presumptive :
  Pus continuous.
  Pain.
    Spontaneous supra-orbital.
    On pressing lacrimal bone.
  Asthenopia.
  Mental depression.

Probable :
  Opacity on transillumination.
  Lesions in middle meatus.
    Anterior rhinoscopy—pus, granulations.
    Probing—pus, blood, bare bone.
Certain :
  Puncture of bulla.
  Elimination of antrum.
       (Exploratory irrigation.)

POSTERIOR GROUP.

SIGNS OF SUPPURATION OF SPHENOIDAL
SINUS.

Presumptive :
  (*a*) Pain.
  (*b*) Ocular disturbance.
Probable :
  Pus.
  (*a*) Between septum and middle turbinal
       (ant. rhinoscopy).
  (*b*) On superior and middle turbinals and
       vault (posterior rhinoscopy).
  Lesions in olfactory slit.
  (*a*) Bulging in depth (in acute cases).
  (*b*) Mucous polypi.
Certain :
  (*a*) Pus from ostium seen.
  (*b*) Exploratory catheterization.
  (*c*) Exploratory puncture.

SIGNS OF SUPPURATION OF POSTERIOR ETH-
MOIDAL CELLS.

Presumptive :
  Same as sphenoidal.
Probable :
  Polypoid middle turbinal.
Certain :
  Return of pus after irrigation of sphenoid.
  Bare bone behind middle turbinal.

CHAPTER IV.

SURGERY OF THE NECK.

CONGENITAL MALFORMATIONS.

THE congenital malformations of the neck are of great interest from a morphological point of view, though few of them are of serious practical importance. They are due to errors in development of (1) the *branchial clefts*, (2) the *thyrolingual duct*, (3) the *lymphatics of the neck*, and (4) the *vertebræ*.

The branchial clefts are four transverse grooves on each side of the neck, analogous to the gill-slits in fishes. They are visible in the early stages of the human embryo, as shown in Fig. 69.

Corresponding with the groove in the epiblast is a similar groove or depression of the pharyngeal hypoblast; some authorities hold that these grooves coalesce, and that the clefts are linear openings from the exterior into the pharynx, as in fishes; but there is no proof of this, and the best authorities hold that the clefts are merely grooves, and that the pharynx is separated from the skin by a thin layer of mesoblast covered by epiblastic and hypoblastic epithelium on its two surfaces. The bar of tissue in front of the most anterior cleft is called the *mandibular bar;* the next bar lying between the

FIG. 69.—Early human embryo, showing branchial arches and clefts.

first and second clefts is the *hyoid bar*, and the other two bars formed by the posterior clefts are called the *first* and *second branchial arches*. The anterior, or *hyomandibular cleft*, develops into the external auditory meatus, the tympanum, and the Eustachian tube; the thin membrane at the bottom of the cleft forms the membrana tympani. The three posterior clefts should all be obliterated in the development of the neck, but if this process is incomplete one of the following deformities may result: 1. Complete branchial fistula; 2. Incomplete branchial fistula; 3. Pharyngeal diverticulum; 4. Branchial dermoid cyst. A *complete branchial fistula* is produced when, added to failure of the coalescence of the arches bounding a cleft, there is a perforation of the membrane at the bottom of the cleft, allowing of a direct passage from the surface to the pharynx. An *incomplete branchial fistula* occurs from failure in the coalescence of two adjacent branchial arches or bars, without perforation of the cleft, so that the track from the surface is shut off from the pharynx.

A *pharyngeal diverticulum* is produced by a failure in the closure of the sides or one of the hypoblastic grooves between the branchial bars. A *branchial dermoid cyst* results from a part of the deeper portion only or a cleft remaining unobliterated, the cleft on the surface and the groove in the pharynx being closed over. This sequestrated portion of skin or mucous membrane develops, and its secretions collect and distend it into a more or less globular cyst.

The pinna is developed from six tubercles which grow around the dorsal extremity of the hyomandibular cleft. At the dorsal extremity of either of the other clefts a similar tubercle may occur and develop into a little mass of cartilage covered by muscle and skin, which is then called a *cervical auricle*. At this spot also the skin may show a different appearance from the rest of the neck, being either less pigmented or covered with thin soft hair. These indications of the dorsal ends of the branchial clefts may be called *Knox's spots*, from the observer who first drew attention to them.

The *thyrolingual duct* is a tubular diverticulum which starts from the furcula and passes

down the middle line of the neck behind the body of the hyoid bone, and bifurcates in
front of the upper part of the trachea.   Its lower end forms the greater part of the isthmus
of the thyroid gland, and blends with the lateral lobe of that body on each side.   The
upper orifice of this duct persists as the *foramen cæcum*, and between that and the thyroid
isthmus the duct should entirely disappear, but several departures from this are known to
occur.   Thus, the upper part of the duct from the mouth to the basihyoid may persist as a
fine tube just admitting a probe, or it may develop into a sublingual dermoid.   The part
behind and just below the basihyoid may persist and be distended into a cyst—*subhyoid der-
moid* or bursa.   Lastly, the infrahyoid part of the duct may persist, and, fluid collecting in
it, form a cyst, and when this cyst bursts or is opened a *median cervical fistula* results.
Tissue like the thyroid gland may develop in the wall of this part of the duct and form
isolated nodules—*aberrant thyroids*—or a continuous process, the *pyramid*.   The lingual
portion of this duct is lined by squamous epithelium, the thyroid portion is lined by colum-
nar ciliated epithelium, and so it happens that the cysts arising from the accumulation of
secretion within different portions of this tube have different contents and different epi-
thelium lining them.   Having thus briefly sketched the mode of origin of these various
congenital defects, we may now study their clinical features in a little more detail.

Branchial fistula is a rare deformity, and may be easily over-
looked.   It appears to be inherited, for it may occur in several gen-
erations of a family, or in several members of a family, and it is not
uncommon to find it occurring along with some other congenital
deformity, particularly a cervical auricle.   The fistula always opens
at the level of the anterior border of the sternomastoid.   A fissure
from failure to close over the thyrohyoid space opens just behind the
angle of the jaw ; one, from failure in the third cleft, opposite the thyro-
cricoid space ; and a fissure connected with the fourth cleft opens just
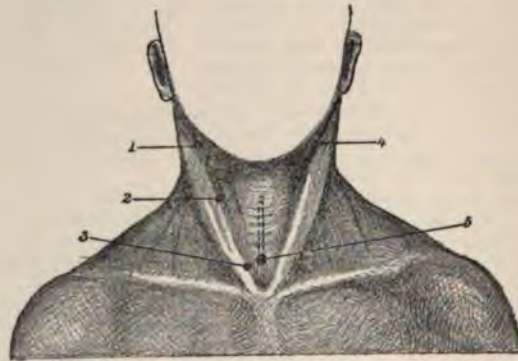
FIG. 70.—Showing the usual places of opening of branchial fistulæ (1, 2, 3) and thyro-
lingual fistula (5) ; 4, incision for removal of tuberculous glands beneath the upper half of the
sternomastoid muscle.

above the inner end of the clavicle (Fig. 70).   If *complete*, they open
into the pharynx just behind or below the tonsil, usually by a narrow,
slit-like orifice, into which, however, fluid may escape in swallowing.
More often they are *incomplete*, and extend deep in the neck toward
the pharynx for 2 or 3 inches.   They lie close to the carotid
blood-vessels, and the relation of the fistula to these vessels and the
nerves of the neck affords interesting evidence of their mode of origin
(Figs. 71–73).

Thus, when the fistula lies in the cleft of the bifurcation of the common carotid artery
and passes above the superior laryngeal nerve, this fact affords strong evidence in support
of the view that the fistula is an unobliterated portion of the second branchial cleft, inasmuch

as the internal carotid artery is developed from the third arterial arch in the first branchial bar ; while the external carotid artery is developed from the first and second arterial arches lying in the mandibular and hyoid bars, and the superior laryngeal nerve is in the first branchial bar.

Treatment.—As a rule, these fistulæ give rise to no serious inconvenience and require no treatment. If the discharge is troublesome,

FIG. 71.—Fistula colli congenita.

FIG. 72.—The same during the act of swallowing.

FIG. 73.—Fistulous tract dissected and shown running between the external jugular vein and the sternomastoid muscle (Warren's case).

or if attacks of inflammation occur in the fistula, it should be dissected out. This operation requires great care, owing to the deep position of the fistula and its proximity to the large vessels of the neck, and should only be undertaken when its necessity is proved.

Pharyngeal diverticula are very rare deformities, which prob-

ably arise from non-closure of a branchial groove and a gradual dila-
tation and prolongation of the pharyngeal pit thus caused. If they
are small and if food does not gain access to them, they give rise to no
symptoms; but if food passes into them, it accumulates there and sets
up catarrh of the mucous lining or even acute inflammation of the wall.
The tumor may then be felt from the outside, and the patient will suffer
from dysphagia or dyspnea, according as the pouch presses upon the
gullet or the trachea (Fig. 74).

   If the condition is diagnosed, the diverticulum should be excised.
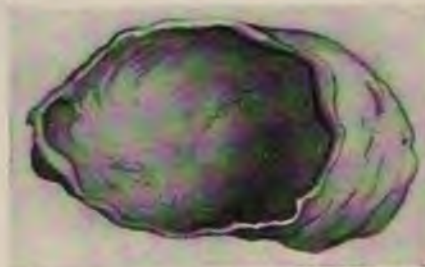For this a careful dissection should be made on to the tumor through

FIG. 74.—Esophageal diverticulum. A sac from the left side of the esophagus of an old
woman. For many years retention of food in the pouch. Removal. Suture of the esopha-
gus. Recovery (Mixter's case; Warren Museum).

an incision in front of the sternomastoid muscle, great care being taken
to avoid the vessels and nerves of the neck. The pouch is cut away,
and the opening in the pharynx is closed by a close series of fine
sutures.   The external wound must not be entirely closed, but either
a large drainage-tube or a tampon of gauze should be left in, passing
quite down to the sutured pharynx.

   Branchial Dermoids.—There are two situations in which cysts
arising from unobliterated portions of branchial clefts and pouches may
be met with—in the mouth between the geniohyoglossus and the mylo-
hyoid or hyoglossus muscles, and in the neck beneath the deep fascia
and close to the carotid vessels.   These cysts are soft, slowly growing
painless tumors, of a more or less distinctly globular outline.   They
may remain stationary for years, or from the time they are first noticed
they may steadily enlarge. The wall usually contains cutaneous struct-
ures, and the contents of the cysts, in addition to epidermic débris, fat,
cholesterin, and sweat, may include hairs. Some more deeply placed
are mucous cysts; these spring from the pharyngeal grooves opposite
the cutaneous clefts. Branchial dermoids are recognized by the struct-
ure of their walls—skin or mucous membrane—and by their position.
The only treatment is excision.   The *sublingual dermoids* may often be
removed through an incision in the floor of the mouth carried down to
the cyst-wall, which is then carefully separated from its surroundings
by a blunt dissector.   The *cervical dermoids* must be removed through
an incision in front of the sternomastoid muscle.   These cysts are
usually not firmly adherent to surrounding parts, and their complete
removal is not difficult (Fig. 75).

   Thyrolingual dermoids are met with in three situations—in the

tongue, at the hyoid bone, and lower down in the neck over the thyroid cartilage.

In **the tongue** these cysts are placed exactly in the middle line, between the two geniohyoglossi muscles; if of large size they push up the tongue, or even force it out of the mouth, and they project below the mandible. They are of slow growth and may remain stationary for years. They are lined with a stratified squamous epithelium and filled with soft yellow sebaceous matter, and they may contain hair or

FIG. 75.—Branchial cyst.

teeth. They are best removed by an incision in the mucous membrane of the floor of the mouth. The cyst-wall is easily exposed and separated from the soft cellular tissue in which it lies. They can be removed by a submental incision in the middle line from the chin to the hyoid bone, carried through the mylohyoid muscle.

At the hyoid bone these cysts are usually small, ovoid in shape, and tense. They lie on the thyrohyoid membrane and project up behind the body of the hyoid bone, to which they are usually fixed. The cyst-wall is thin, and the contents are mucoid. They have been thought to be bursæ, and have been described as subhyoid bursæ; but an examination of their wall shows them to be lined with columnar epithelium, which may be ciliated. They are best removed by means of

a transverse incision immediately below the body of the hyoid bone. The deep cervical fascia is divided, the sternohyoid muscles are separated, and the cyst thus exposed is carefully separated from the hyoid bone and the thyrohyoid membrane and removed entire.

The lower part of the thyrolingual duct may form a **cyst over either the thyroid or cricoid cartilage** or the very highest part of the trachea. They are usually small, tense, painless swellings, placed either in the middle line or on the left side. They are liable to enlarge and burst externally, and then leave a sinus which refuses to heal. This sinus opens in or close to the middle line and runs up beneath the sternohyoid muscles, usually as high as the hyoid bone, to which its upper end may be firmly fixed (Fig. 70). The cyst is originally lined with columnar epithelium on which cilia may be found, but as the result of inflammation this may be more or less destroyed and replaced by granulation-tissue. In the wall of the sinus small areas of tissue exactly like the structure of the thyroid gland may be found. The cases of aberrant thyroids or bronchoceles which lie in front of the larynx develop from the thyrolingual duct.

The only *treatment* to be recommended for either the cyst or the fistula is complete removal. A probe should be passed along the whole length of the fistula, and an incision of the same length is then made through the skin, platysma, and fascia; the sternohyoid muscles are separated, and the exposed fistula is then removed entire, great care being taken to excise its upper extremity, for if any part is left behind, its epithelial lining continues to secrete, and the fistula persists.

Cystic Hygroma of the Neck.—Children are sometimes born with large, irregular, multilocular, cystic tumors lying deep in the neck beneath the sternomastoid muscle in close relation with the carotid vessels, or in the posterior triangle of the neck: sometimes the cystic mass extends along the subclavian vessels into the axilla. Such cysts vary in size from a pea to an orange; they are smooth, lined with a single layer of flattened lymphatic endothelium, and their contents are limpid fluid. The cysts are bound together by a varying amount of fibrous and fatty tissue. The tumor is not encapsuled, but is firmly blended with the sheaths of adjacent vessels and muscles, and is generally attached to the skin. Such tumors form irregular swellings in the neck or axilla, often of large size. They are soft, painless, and fluctuating in places, with firmer masses felt between the larger cysts. They are very liable to attacks of inflammation, in which great swelling occurs, with redness of the skin, local edema, and fever. When the inflammation subsides, it is found that one or more of the cysts no longer fluctuates as before, and that later on it shrinks and may disappear. These acute attacks have an alarming aspect, but are really curative in effect, obliterating cyst after cyst until only a shrunken solid band or cord is left to represent the original cystic mass. The tumor may gradually shrink and disappear without any attack of acute inflammation.

There is no satisfactory **treatment** of these cases. Excision of the mass should not, as a rule, be attempted, as it is attended with the gravest difficulties and dangers, owing to the absence of any circumscription of the mass and owing to its close attachment to the sheaths

of the vessels. Tapping the cysts does no good; the injection of irritants, such as iodin and phenol, into the cysts sometimes succeeds, but may excite dangerous inflammation. Setons are useless and dangerous; external applications, such as plasters and ointments, are of no avail. As already stated, the tumor is often gradually obliterated by repeated attacks of inflammation. During the attacks of inflamma-
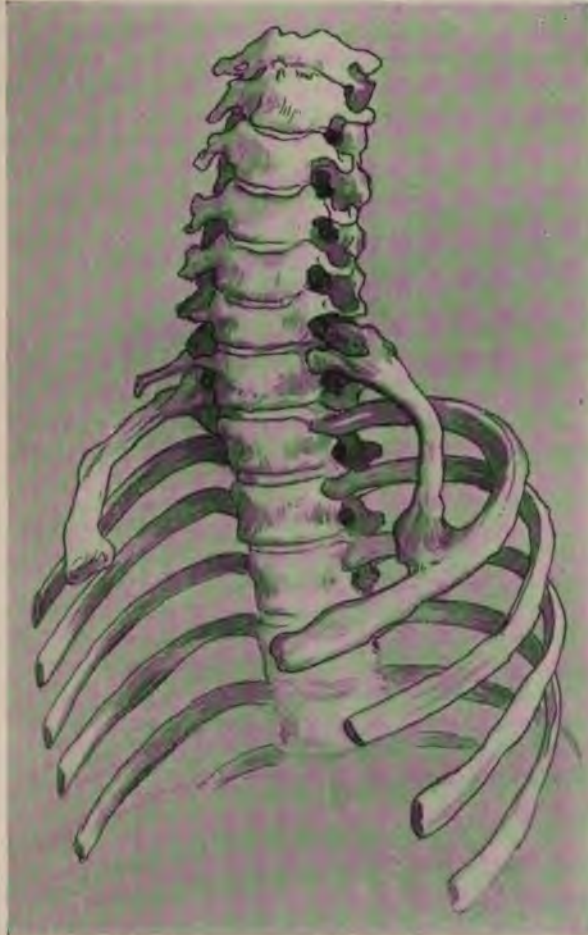
FIG. 76.—Cervical rib (Warren Museum).

tion hot sedative fomentations—belladonna or opium—should be assiduously applied, and if suppuration occurs, a free incision should be carefully made.

A single **lymphatic cyst** with thin wall lined with lymphatic endothelium and clear limpid contents is occasionally found under or behind the sternomastoid muscle. These cysts are of very slow growth, and are usually not noticed till some years after birth. They form globular swellings, smooth, fluctuating, and not tense, and if large and projecting sufficiently, they may be seen to be translucent. A single cyst of

this kind should be dissected out, great care being taken in separating it from the great vessels. Both these forms of lymphatic cystic tumor are believed to be due to an error in development of the lymphatic vessels of the neck.

Cervical Rib.—An additional rib is sometimes found connected with the seventh cervical vertebra. It may be unilateral or bilateral, complete or incomplete. When complete, it forms an arch of bone above the first dorsal rib, and is tipped with cartilage and united anteriorly to the cartilage of the first dorsal rib. The subclavian artery passes over the rib and is raised by it above its normal position, so that the pulsation of this artery and the thrill easily produced by gentle pressure of the artery against the rib may suggest the presence of an
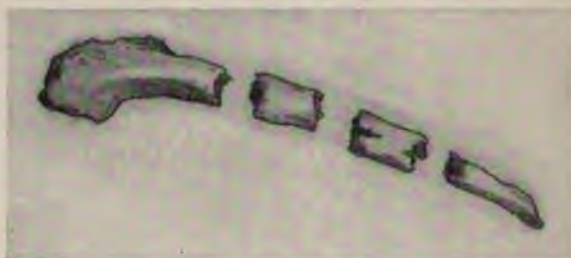
FIG. 77.—Cervical rib removed for brachial neuralgia from a woman thirty-five years of age. Cure (Warren).

aneurysm. The brachial plexus is also over the rib, and in some cases the bone causes painful pressure upon the nerves (Figs. 76, 77).

As a rule, no **treatment** is required for this condition. Its chief importance lies in the errors of diagnosis to which it may give rise, it being liable to be mistaken for a new growth or an aneurysm. In the rare cases in which by its pressure it causes pain, the rib may be excised. The operation is done through an incision across the base of the posterior triangle. With a blunt dissector the soft parts are separated from the bone, which is then divided at each end by bone-forceps. The proximity of the subclavian vessels and the cervical nerves must be borne in mind.

INJURIES OF THE NECK.

Contusions of the neck are not very common; they are caused by blows, especially in boxing and fighting, and by squeezing force, as in garotting and hanging.

In addition to the ordinary effects of contusion, **fracture of the hyoid bone and of the cartilages of the larynx** may be produced. The great cornu of the hyoid bone may be broken at any part and in more than one place; the superior cornu of the thyroid cartilage may be broken off, transversely or obliquely, and may then be displaced upward, outward, or forward. The pomum Adami may be flattened by the opening out of its angle, or either ala may be curved inward as well as broken. The cricoid cartilage may be fractured vertically with or without displacement, and the trachea may be severed. In the slighter cases of these injuries the patients experience some difficulty

and discomfort in speech and deglutition, and a careful examination of the parts reveals the lesion by the displacement and mobility of the fragments. The fractures may unite by fibrous tissue or by bone. When the lesion is more severe, there are great swelling, dyspnea, dysphagia, and danger of suffocation, either from displacement of the parts or from swelling.

Suppuration may occur in connection with these fractures, and the pus then burrows in the neck and bursts into the mouth, larynx, or pharynx. This greatly adds to the patient's distress and also to the danger from dyspnea and bronchopneumonia. Severe *shock* may occur from contusions of the front of the neck even when no fracture is caused.

Treatment.—In the slighter cases, rest in bed for a few days, with some form of support to the part, such as a properly applied bandage, is all that is required. In severe cases any shock present must be combated by heat to the precordia and feet, and by general stimulants. Dyspnea, if severe, must be at once relieved by tracheotomy, and the patient must be nursed with the greatest care. Should symptoms of suppuration supervene—increased ill-defined brawny swelling, increased local pain and tenderness, and pyrexia—free incisions down to the inflamed cellular tissue must be made at once, and hot antiseptic fomentations applied. If respiratory obstruction persists, tracheotomy must be performed. The surgeon must never forget the danger of dyspnea; it may come on suddenly from some abrupt displacement of a fragment of cartilage, and he should hold himself in readiness to operate at any moment.

Wounds of the throat are frequent and very important. They are most often suicidal, but they may be homicidal or accidental. They are inflicted by razors, knives, scissors, daggers, swords, and cutting-instruments of all kinds, and by bullets.

A **cut throat** may be of the nature of a stab or a punctured wound, but is generally an incised wound. When suicidal, the wound is usually on a higher level at the left end of the cut, and extends farther to the left than to the right of the middle line; the edge is often jagged, especially on the left, and there may be slighter scratches or cuts due to the ineffectual efforts of the would-be suicide. These wounds may be classified according to their depth into *superficial* or *non-penetrating, penetrating*—those that extend into the air-passages, and in some cases into the food-passage as well; and *complete* where all the structures in front of the neck are divided quite down the spine. They are also classified according to their height in the neck into: (1) those above the hyoid bone, (2) those through the thyrohyoid membrane, (3) those through the larynx, and (4) those through the trachea. It will be well to notice the parts liable to injury at these different levels.

Above the Hyoid Bone.—The wound may involve the skin, platysma, cervical fascia, digastrics, mylohyoid, geniohyoid, geniohyoglossus, hyoglossus, and sternomastoid muscles, and deeper still, the intrinsic muscles of the tongue: the facial, lingual, and external carotid arteries, the facial, lingual, and external jugular veins, the hypoglossal nerve, and the submaxillary gland and its duct. Wounds in this

situation bleed very freely and gravely interfere with the movements of the tongue, and therefore with deglutition.

Through the Thyrohyoid Space.—This is the common seat of suicidal wounds. The parts that may be injured are as follows: Skin, platysma, cervical fascia, anterior and external jugular veins, sternohyoid, thyrohyoid, and sternomastoid muscles, the superior thyroid and external carotid arteries, the superior laryngeal nerve, the thyrohyoid membrane, and the epiglottis. Wounds in this situation are attended with less hemorrhage than those higher up the neck; the pharynx is generally penetrated, and division of the superior laryngeal nerve may lead to permanent anesthesia of the side of the larynx involved.

Through the Larynx.—In addition to the more superficial structures, the thyroid cartilage may be severed either above or below the vocal cords. The superior thyroid arteries and carotid vessels may be wounded; but the deep position of the carotid vessels beneath the thick sternomastoid muscle very securely protects them from injury.

Through the Trachea.—This is the least frequent seat of these wounds. The thyroid gland and its vessels, the carotid vessels, and the trachea are the other parts most exposed to injury.

The **peculiarities and dangers of cut-throat** wounds are (*a*) the *hemorrhage* that may attend them. If the common carotid vessels are divided, death is certain and almost immediate; the bleeding from the smaller vessels is often profuse, and blanches the patient. (*b*) If the wound is in the lower part of the neck, there may be *entrance of air* into a vein, causing either instant death or very great embarrassment of the circulation. (*c*) The great frequency of *wound of the air-passages*, with the attendant dangers of asphyxia from blood flowing into the bronchial tubes, and of septic *bronchopneumonia*. (*d*) Wide *gaping* of the wound and very slow healing; in some cases a *fistula* communicating with the air-passages persists. (*e*) Wound of the larynx may cause permanent *aphonia*. (*f*) Division of the superior laryngeal nerve causes *anesthesia* of the same side *of the larynx*, and in deglutition food may pass into the trachea and lungs and set up bronchopneumonia. (*g*) The patients are generally suffering from great *mental depression*, occasionally from maniacal excitement; they may refuse to take food and resist all efforts to feed them artificially, and in some cases they will tear open the wounds afresh.

The causes of death in cases of cut throat are hemorrhage, entrance of air into the heart, asphyxia from blood entering the lungs, or from inflammatory edema of the glottis, bronchopneumonia, and exhaustion.

The **treatment** of these cases has been greatly improved of late years. All hemorrhage should be at once arrested by ligaturing bleeding vessels. The wound and the skin around should next be carefully cleansed, but antiseptic lotions must not be allowed to enter the air-passages. The divided tissues should then be united as accurately as possible by buried and superficial sutures. This must be done with great care, so as to unite exactly the severed parts and obtain complete apposition of the wound. If the epiglottis or laryngeal cartilages are

divided, they must be united by sutures. If necessary, an anesthetic should be given to permit of the careful closure of the wound. The entire wound should be closed and a dressing of wetted double cyanid of mercury and zinc gauze and wool fastened round the neck with a bandage carried also over the head. The patient should be placed in bed on his back, with the head raised. The next point to attend to is to feed the patient. If the pharynx or esophagus has been opened, or if the superior laryngeal nerve has been divided, the patient must be fed artificially. The best plan is to pass a large new French catheter through the mouth into the esophagus, and through that to inject slowly warm milk and egg. Two quarts of milk, three eggs, and some tea should be administered daily. Some prefer to pass the tube through the nose. If a soporific or a purgative is required, it is administered with the food. The patient must be watched to see that he does not interfere with the dressing and tear open the wound.

The part should be dressed on the second day. If there is any swelling or sign of inflammation at any part, the stitches at that part should be cut. Should edema of the glottis supervene, the wound should be opened up, the glottis scarified, and if that does not remove the obstruction, tracheotomy should be at once performed.

Hematoma of the Sternomastoid.—Children at or soon after birth sometimes present a firm rounded swelling in the sternomastoid muscle. These are traumatic in origin, and are the result of more or less extensive rupture of the sternomastoid muscle with hemorrhage into its sheath.

The swelling is usually not noticed until a few days or even a few weeks after birth; it is generally unilateral, but has been seen on both sides. It may be found at any part in the length of the muscle, and is about equally frequent on the two sides. It is usually of small size— as large as a cherry or a gooseberry—but has been known to involve the entire muscle. The tumor is firm, rounded in outline, painless, and not tender; when of large size its center has been known to be soft and fluctuating. The skin over it is not discolored, and there are no signs of bruising. The swelling gradually lessens in size and disappears spontaneously. In very rare cases a small induration may persist for years at the site of the tumor. In a certain number of cases, probably about 20 per cent., a shortening of the muscle, leading to torticollis, ensues (see p. 110).

A section of these swellings examined with the microscope shows fragments of muscle-fiber undergoing degeneration, surrounded by a quantity of fibrous tissue. In the earlier stages there are evidences of effused blood. The sheath of the muscle is untorn.

It is thought that in a very few cases the muscular rupture is due to intra-uterine violence. In the great majority of cases, however, the lesion occurs during parturition, either from the stretching of the neck which occurs as the head turns forward over the pubes, from traction on the head by the accoucheur's hands or forceps, or often by traction upon the after-coming head. The condition is most often met with in first-born children, and after long natural labor, breech-presentations, or where turning has been necessary.

The tumor requires no active treatment, for it undergoes spontane-

ous absorption; but careful gentle friction and movements of the head should be practised to hasten this absorption and to prevent any permanent shortening of the muscle.

TORTICOLLIS, OR WRY-NECK.

This is a deformity produced by contraction or permanent shortening of one sternomastoid muscle, aided in some cases by the same change in other cervical muscles.

Causes.—The cases have been commonly divided into two classes, the congenital and the acquired; but it is exceedingly doubtful if it is ever really congenital—*i. e.*, present at the time of birth. The most frequent cause of torticollis is an injury of the muscle (hematoma) received during birth (see p. 109). The result of this is noticed when the child is a few months old, and, in the absence of obvious postnatal cause, the deformity was assumed to be allied in nature to talipes, and so was spoken of as congenital. Other causes of the deformity are abscesses beneath the sternomastoid muscle, cervical caries, and hysteria. In painful affections of the side of the neck, such as acute inflammation of a gland, the head may be held in the position of wry-neck to relax the tension of the part and relieve the pain; but the sternomastoid muscle of the affected side is relaxed, not contracted, and the attitude is caused by the contraction of the muscles on the other side of the neck. In large abscesses beneath the sternomastoid muscle, also, the head is held in a position to relieve pressure. As a rule, in these cases the position is quickly corrected when the acute or chronic abscess is treated; but in some few cases of long-standing inflammation adhesions may persist, fixing the muscle in its unnatural position. In cervical caries there is rigidity of the muscles of the neck, and in some cases the face is twisted to one side and not held straight. Here the deformity is but a part of a general muscular spasm in the neck. There are a few cases in which one sternomastoid muscle is held contracted without any obvious cause of the contraction, and in which the cause is functional or hysterical.

The **deformity** varies in degree in different cases. The head is held in the position it assumes under the contraction of one sternomastoid. The occiput is approximated to the shoulder of the affected side; the chin is raised and turned to the opposite side, and the ear of the same side is depressed toward the shoulder. Any attempt to correct this position is resisted by the prompt contraction of the sternomastoid muscle; if the head is thrown back, the deformity becomes less marked. If the trapezius is contracted, too, it stands out prominently, and the shoulder is raised.

Secondary Changes.—If a child is allowed to grow up with this deformity, the side of the face which is drawn down does not develop so fully as the opposite side, and when growth is complete there is a marked asymmetry of the face. This fact has been used as an argument in support of the view that this form of torticollis is due to some lesion or defect in the central nervous system causing unequal development of the two sides of the face and neck. This view is untenable, however.

In long-standing cases other secondary changes occur in the spine and the lateral muscles of the neck. The cervical spine is curved—concave on the affected side—the intervertebral disks being compressed, thinned, and fibrous on the concave side, and sometimes reduced to a thin layer of cartilage on each vertebra, with a space between. The bones, too, show changes, the bodies of the vertebræ being lipped on the concave side, the articular processes enlarged, and the transverse processes thickened and sometimes united together by bone. The curve in the cervical spine leads to compensatory curvature lower down. The scaleni and other muscles on the side of the neck whose attachments are approximated by the attitude of torticollis become permanently shortened or, rather, do not develop to their full length.

Treatment.—The facts just stated afford the strongest reason for correcting this deformity early, for when these secondary changes have occurred, treatment can never be entirely satisfactory.

In the slightest form of the malady and in its earliest stages, particularly when it has resulted from inflammation beneath the sterno-mastoid muscle, careful friction of the side of the neck (massage), and active and passive movements of the head will be sufficient. To this treatment may be added, in slightly more severe cases, the wearing of an apparatus to hold the head in the corrected or over-corrected position. In the majority of cases, however, and in all cases where it is impossible to correct the deformity under an anesthetic, the sterno-mastoid muscle must be divided. This can be done subcutaneously or by the open method.

Subcutaneous Section.—Until lately this method was invariably adopted. The sternal head is severed quite close to the sternum by passing a sharp-pointed tenotome beneath it and cutting out toward the skin. The clavicular head is more difficult to divide. A puncture should be made through the skin, platysma, and cervical fascia at one border of the muscle and close to the clavicle; a round-ended tenotome should then be passed beneath the muscle, the cutting edge of the knife being kept along the bone; then the edge is turned toward the muscle, which is divided by quick, short movements. Care has to be taken not to injure either of the great veins close beneath the muscle—the innominate, subclavian, or external jugular. At the same time it is necessary to sever the whole muscle, and in some cases thickened bands of the sheath as well. It is far better, therefore, in all cases in which the clavicular part of the muscle requires division to resort to the open method.

The Open Method.—A transverse incision is made over the muscle, a finger's breadth above the clavicle; through this the muscle is carefully divided, and if necessary, fibrous bands or thickenings of the deep layer of its sheath. A continuous suture is then passed through the coverings of the muscle and the wound covered with a collodion dressing. The incision leaves a scarcely perceptible scar.

After division of the muscle care must be taken to stretch that side of the neck and prevent union of the divided parts in their shortened state. As soon as the skin-wound is healed, the patient must be taught to move the head to the full extent possible in every direction, and

particularly to put the other sternomastoid into full action. These active movements are of the utmost importance, and when the patient is old enough to carry out this treatment and will do so energetically, little else is needed. Passive movements by the surgeon, particularly turning the face well round to the opposite side and approximating the opposite ear to the shoulder, must also be made. Massage to the affected side of the neck should also be practised twice a day. In most cases it is desirable to wear some form of apparatus to keep the neck well stretched. The simplest form is that shown in Fig. 78.

FIG. 78.—Wry-neck apparatus.

This mechanical treatment should be continued until the tendency to return to the position of wry-neck has passed off. This time varies much in different cases. In some all treatment can be suspended a month after the operation; in others it must be continued for six months or even for a year.

Spasmodic Torticollis.—Under this name are included all cases of spasm of cervical muscles. The sternomastoid is affected far more frequently than any other of the cervical muscles, and so the position of the head is most often that of wry-neck. The spasms may be limited to one muscle—most often the right sternomastoid—or it may involve two or more muscles in the neck, and may involve also muscles in the arm, face, or scalp.

The **pathology** of this distressing affection has not been determined. It is believed to depend upon some pathological change in the nerve-cells connected with the roots of the nerves supplying the affected muscles, or in those of the associated cortical area, but it is not known in which of these two positions—if in either—the lesion really lies. The affected muscles may show some hypertrophy from over-use; their opponents are not paralyzed.

Etiology.—Very little is known of the exact causation of spasmodic

wry-neck. It occurs twice as often in women as in men, and is rare before the age of thirty. Some of the patients are distinctly "neurotic" and have, or have had, other nervous affections, or nervous diseases have occurred in other members of their family. Depressing emotion, injury to the neck or head, exposure to cold, and over-use of the neck-muscles seem occasionally to excite cervical spasm. In very many cases no definite cause can be assigned for the trouble.

Symptoms.—The spasm may be constant (tonic) or intermittent (clonic) or a combination of the two, tonic spasm being made worse by the addition of clonic muscular contractions. The sternomastoid is the muscle most often affected; next in frequency comes the cervical part of the trapezius, then the splenius, and occasionally other muscles are affected too. The position into which the head is moved varies with the muscles involved. With spasm of the right sternomastoid the face is turned to the left and the right ear is approximated to the shoulder. If the trapezius of the same side is affected, the position of the head is the same and the shoulder is raised. One trapezius draws the occiput back with slight rotation of the face to the opposite side and raising of the shoulder. If the trapezius is contracted on both sides, the head is drawn back (retrocollic spasm) without rotation, and along with this there is contraction of the frontalis muscle, wrinkling the forehead. If the two sternomastoids are affected, the head is thrown back without rotation. The splenius of one side rotates the face to its own side. If contracting with the opposite sternomastoid, it increases the rotation of the face; but contracting with the sterno-mastoid of the same side, it lessens the rotation of the face while increasing the lateral flexion of the head.

The affected muscles can be seen and felt standing out under the skin, and they may be larger than their fellows. The spasm varies much in intensity and in frequency. It is usually excited by any voluntary effort to contract the affected muscle, and is increased by opposing the spasm, as by pressing the head in the opposite direction. The condition is not directly painful, but a sense of fatigue is complained of in the worst cases, and in the clonic form the constant jerking movement, often interfering with all work, quickly produces a depressed mental condition.

Prognosis.—The spasm may remain stationary for years. In some few cases it gradually lessens; in other cases it spreads to other muscles and other parts of the body. The outlook, therefore, is always grave.

Treatment.—No good is effected by wearing any apparatus to restrain or oppose the movements of the head; division of the affected muscle or muscles is also a wholly useless procedure and should on no account be practised. General tonics, especially in the anemic and weakly, may do a little good. A complete change of scene may be recommended to those in whom the spasm has supervened upon a severe nervous shock of any kind. Sedatives have been largely used, and in many cases the spasm can be allayed by large doses, but almost invariably returns when the medicine is discontinued. Opium and its alkaloids, cocain, and bromids are the drugs most used; but they can only be recommended with grave misgiving, as, if the spasm is relieved,

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the treatment usually establishes the morphin- or cocain-"habit." Electricity in all forms has been employed, but without success. The most successful measure is excision of the nerves supplying the affected muscles. Nerve-stretching and simple division of the nerves (neurotomy) have also been employed; but their good effects are temporary, and the spasm generally returns when the function of the nerve is restored.

Neurectomy gives the best result when a single muscle, and particularly the sternomastoid, is affected. The spinal accessory nerve should be exposed by an incision 2½ inches long over the anterior border of the highest part of the muscle. This is carefully exposed and turned back until the nerve is seen passing across the internal jugular vein to enter the muscle opposite the angle of the jaw. The nerve is raised, and with the finger and thumb its central end is gently and steadily drawn upon; it will be felt gradually to yield, and some 4 or 6 inches of the nerve will be drawn out and can then be cut off. This method of drawing out the long root of the nerve has in the writer's hands yielded excellent results, and is to be preferred to merely cutting out the portion of the nerve exposed in the wound. The operation paralyzes the cervical portion of the trapezius as well as the sternomastoid and is followed by wasting of these muscles, but this leads to no serious inconvenience. When the spasm is more widespread, it becomes a more difficult matter to deal with it by neurectomy, yet success may even then be attained.

Posterior Neurectomy.—When the posterior muscles of the neck are involved in the disease, the nerves to be excised are the posterior primary divisions of the first, second, and third cervical nerves. This may be conveniently done by a transverse incision at least 3 inches long, placed below the lobule of the ear and extending outward from the middle line. The trapezius is cut across and its two parts reflected. The comparatively large second cervical nerve (great occipital) is to be found and traced through the complexus muscle to the spine. Its central part is then carefully excised. The first nerve is seen on the arch of the atlas, close beneath the vertebral artery; its division must be very carefully made. Below the second cervical spine the inner division of the third nerve is to be sought, and its central portion excised. It is in only a few cases that this operation is indicated, especially where the area of spasm is very limited. The operation is one of some delicacy and difficulty.

CELLULITIS OF THE NECK.

Acute diffuse inflammation of the cellular tissue of the neck is a very grave affection; in its typical form it is due to infection with the Streptococcus pyogenes. This organism may gain access through an external wound, as a cut throat or tracheotomy wound, or an internal wound of the mouth, pharynx, esophagus, and larynx, such as is inflicted by a pin, fish-bone, tooth-plate, or some other sharp foreign body. Diphtheria and scarlatina are other sources of infection from the pharynx. Acute inflammation about a tooth or the lower jaw or in the ear may also set up this disease.

The special features of the disease as it occurs in the neck are these: 1. Owing to the number and size of the veins, phlebitis, spreading septic thrombosis, and pyemia are liable to occur. 2. As the cellular tissue of the neck is continuous on the one hand with that of the axilla and on the other with that of the mediastinum, the disease tends to spread into the axilla or into the thorax, and there set up suppurative mediastinitis, pleurisy, and pericarditis. 3. The infiltrated cellular tissue bound down by the muscles and the deep cervical fascia may compress the trachea and the large veins and the important nerves, causing dyspnea, cerebral congestion, and paralysis of the vagus and its branches. Still more often does the inflammatory edema spread to the loose cellular tissue around the upper opening of the larynx and cause edema glottidis, with grave danger from asphyxia. 4. The large number of lymphatics and veins favors a rapid absorption of the poisonous toxins and the passage of the infective organisms themselves into the blood-stream, and the close proximity to the right and left lymphatic ducts removes the protection afforded by the passage of poisonous organisms or toxins through a long series of lymphatic glands. Hence we find that this form of cellulitis is attended with all the symptoms of toxemia in an aggravated form—fever, rapid pulse, great depression, low pneumonia—besides septicemia and pyemia.

Treatment.—The patient must be supported by a nourishing fluid diet—milk, and meat-broths, and extracts; the bowels may require to be cleared by a purge, while the skin must be kept clean, and everything that good nursing can do to maintain the vital forces must be attended to. As soon as the condition is recognized, a free incision should, if possible, be made into the infected cellular tissue. In the neck this presents special difficulties, owing to the importance of the vessels, nerves, and other structures. According to the site of the inflammation, incisions may be made in the middle line or in front of or behind the sternomastoid muscle. These incisions should not be mere punctures, but free incisions. Hot antiseptic fomentations—preferably of carbolic lotion—should then be applied and frequently changed.

Submaxillary Cellulitis, or Ludwig's Angina.—Ludwig was the first to draw attention to a very dangerous form of cellulitis occurring beneath the deep cervical fascia, between the lower jaw and the hyoid bone, and this condition is therefore called angina Ludovici. The streptococcus usually gains access from the mouth, often through a vesicle close by the frenum linguæ, sometimes also through the teeth by way of an alveolar abscess. It is stated that the suppuration may extend from the ear along the digastric muscle to the submental region.

The inflammation causes a brawny swelling below the chin, painful and tender; the skin over it is reddened. The tongue is pushed up in the mouth by the edematous fascia beneath it, and the tongue is itself swelled and thickly furred. This causes difficulty in breathing, speaking, and swallowing, and adds greatly to the patient's distress. There is fever, the temperature ranging high; sometimes a rigor occurs. There is great liability to edema glottidis, and if the patient escape this danger he will die of low pneumonia, septicemia, or pyemia. To save him the surgeon must act very promptly and energetically. The

usual treatment is an incision through the deep cervical fascia, in the middle line of the neck, from chin to hyoid bone. I have obtained better results from a free transverse incision several inches long across the middle of the submental space; the infiltrated fascia may then be opened up still more by the finger (Fig. 79, 1). Seropus drains away, and if the incision is made sufficiently early and sufficiently free, the relief to the patient is immediate. Hot carbolic fomentations are the best dressing to apply over the wound.

DISEASES OF THE CERVICAL LYMPHATIC GLANDS.

Before considering the diseases of the lymphatic glands of the neck, it will be well to review briefly the position of the different groups of these glands and the areas drained by them.

The *suboccipital glands* lie just below the superior occipital curved line. They receive the lymph from the back of the scalp and discharge it into the glands lying close to the external jugular vein.

The *mastoid glands*, lying over the mastoid process, receive the lymph from the lateral part of the scalp and the back of the pinna ; they drain into the external jugular glands.

The *parotid lymphatic glands* lie over, and sometimes embedded in, the salivary gland ; they receive lymph from the temple, the cheek, the ear, and the outer part of the eyelids. Lymph passes from them into the submaxillary glands and the external jugular glands.

The *submaxillary lymphatic glands* lie below the body of the mandible. They are numerous and very important owing to the frequency with which they are infected. They drain the floor of the mouth, the anterior part of the tongue, the lips, chin, *alæ nasi*, and the parotid lymphatic glands.

The *external jugular lymphatic glands* are so called because they accompany this vein and lie with it between the platysma and the cervical fascia. They drain the occipital and mastoid glands, the pinna, the salivary glands, and the neck. They themselves pass on the lymph to the deeper glands. These five sets form the superficial cervical glands.

Lingual Glands.—Lymph from the posterior part of the tongue passes into two or three glands lying on the hyoglossus muscle ; from thence it passes into the deep cervical glands.

Pharyngeal Glands.—One gland is behind the highest part of the pharynx ; others lie on the side of the superior constrictor muscle. They receive lymph from the pharynx, palate, nose, and upper jaw, and thence it passes into the deep cervical glands.

The *supraclavicular glands* lie close to the clavicle in the posterior triangle ; into them the lymph passes from the highest axillary glands and the lowest external jugular glands, and it passes on to the lowest deep cervical gland.

The *deep cervical glands*, or *internal jugular glands*, form a continuous chain along the jugular vein beneath the sternomastoid muscle. They receive lymph directly from the interior of the cranium, larynx, trachea, thyroid gland, pharynx, esophagus, and deep muscles of the neck. Efferent lymphatics from the other cervical glands also enter them at different levels in the neck.

Acute Inflammation; Glandular Abscess.—Causes.—Acute inflammation of a gland may be excited by the absorption of irritating matter, and especially by the passage of pyogenic organisms from any of the areas drained into the various glands. Among the most frequent causes are the lesions of the scalp associated with pediculi capitis—especially in cachectic individuals—erysipelas of the face and scalp, scarlatina, diphtheria, tonsillitis, and disease of the teeth and gums.

Pathology.—The acute inflammation of the gland itself is always accompanied by the same changes in the cellular tissue around the gland. This inflammatory edema adds to the swelling and blurs the outline of the swollen gland. When suppuration occurs, the pus may rapidly point and reach the surface; but if one of the deep glands is affected, the inflammation may extend widely beneath the sternomas-

toid muscle, and a very large abscess form before the pus burrows through the deep fascia and reaches the surface. In these circumstances the large vessels in the neighborhood may be involved, and septic thrombosis of the internal jugular vein or ulceration into the carotid artery may lead to pyemia or hemorrhage. In these cases of neglected suppuration beneath the deep fascia of the lower part of the neck, the inflammation may extend into the chest and cause mediastinal abscess, pleurisy, and pericarditis. After the abscess has burst or been opened, a certain amount of thickening remains for a time, and muscles may be matted together and their action interfered with. Torticollis may be caused in this way.

Symptoms.—The first symptom is a painful tender swelling of the gland, which has an ill-defined outline and is fixed to the surrounding parts. If a superficial gland is affected, the skin over it is reddened and edematous; if it is a deep gland, there may be no redness at first, but the head is held rigid and in such a position as to relax the pressure of the muscle over the gland. The swelling rapidly increases, fluctuation and then pointing are recognized, and the abscess, if superficial, bursts and discharges thick, creamy pus. In the case of a deep abscess the swelling extends beneath the muscle, the superficial fascia becomes edematous, and the skin over it glossy, with a pink or deeper red blush. Fluctuation is difficult to obtain, pointing occurs in front of or behind the sternomastoid very slowly, and the abscess attains very large dimensions before it bursts. The pain of these deep abscesses is very great, and any attempt to move the head adds to it greatly. Dysphagia and dyspnea may increase the distress. The temperature is raised, often ranging as high as 103° or 104° F.; the pulse is quick, the tongue thickly furred, bowels confined, urine loaded, and in addition to the local pain, headache may be severe. All these symptoms are much worse in the deep than in the superficial abscesses. In them sleeplessness and the inability to take or assimilate sufficient food add to the initial cachexia.

Should septic thrombosis and pyemia develop, the course of the fever becomes changed, and rigors and sweatings and the other symptoms of this disease are recognized. If the abscess has ulcerated into a large artery and blood is poured into the abscess—happily a very rare event—the swelling becomes suddenly much larger and tenser, the pain is greatly increased, and an indistinct pulsation may be detected in it.

Treatment.—In the first stage of the inflammation the patient should lie in bed with the head and neck well supported and at rest; the inflamed part should be smeared with a mixture of extract of belladonna and glycerin, and over that a hot fomentation should be placed, and frequently changed. Some prefer to use poppy-head or lead fomentations. At the same time any local source of infection should be attended to. The diet of the patient should be regulated by the height of the fever, the state of the throat, and the power of deglutition, and the bowels may need to be cleared by a purge. If under this treatment the fever subsides, and the swelling and pain lessen, the fomentations may be discontinued and the part wrapped up in cotton-wool and a flannel bandage till all swelling is gone.

When suppuration occurs, and as soon as the surgeon can recognize it, the abscess should be opened. If the abscess is in connection with one of the superficial glands, an incision of sufficient length should be made into its cavity, regard being paid to the position of the superficial vessels and the natural creases in the skin, so that the scar shall be as inconspicuous as possible. The cavity is to be washed out with a gentle stream of warm antiseptic lotion.

In the case of a deep abscess greater care is needed. An incision should be made through the skin over the abscess in front of the sternomastoid. If at the upper part of the neck, the incision should be oblique in a direction downward and forward; if at the lower part of the neck, the incision should be transverse; in either case, it should be about an inch in length. A grooved director is then carefully pushed through the fascia into the abscess, and when pus is seen welling up in the groove, closed dressing-forceps are introduced along the groove; they are then opened and slowly withdrawn open, so as to tear and stretch the fascia and make a sufficient opening into the abscess. In this way a deep abscess can be opened without fear of injury to vessels. In a few cases it may be well to make a second opening into the abscess behind the sternomastoid muscle. After thorough flushing of the abscess-cavity, a drain of sufficient size is placed in the wound, and fastened by a stitch on each side. A hot antiseptic fomentation is the best form of dressing. As soon as the discharge is reduced to a few drops of serum only, the tube should be removed. If the side of the neck remains hardened and the movements of the head are impeded, careful massage will be of use in absorbing the inflammatory products.

Hemorrhage into an abscess is an exceedingly serious complication, and demands the most prompt treatment. An incision just large enough to admit the surgeon's finger should be made, and the left forefinger should be thrust into the abscess to feel for and compress the bleeding vessel. The incision should then be quickly and freely enlarged, the mixture of blood and pus being allowed to escape or washed away. Then the ulcerated vessel must be secured by a double ligature of silk above and below the opening into it.

When the surgeon has in this way arrested all hemorrhage, the abscess-cavity should be well swabbed over with a solution of chlorid of zinc, 40 gr. to the oz., and then dressed antiseptically. Such a case should be carefully watched, so that if bleeding recur it may be at once arrested by pressure until the bleeding vessel can be secured by a ligature. Ulceration into a large vessel may occur after the abscess has been opened. In a case under my care of an old man with a large deep cervical abscess, fully 2 inches of the common carotid artery was found to be destroyed.

Tubercular Disease of Cervical Glands.—Etiology.—The *vera causa* of tubercular disease of glands, as of tubercle in any situation, is the tubercle bacillus. The bacilli are carried to the glands in the lymph, mainly, if not exclusively, in the lymphocytes. The conditions favoring this occurrence are the presence of large numbers of bacilli on the mucous membrane of the nasal and buccal cavities, the virulence of these bacilli, abrasions of the epithelium, the occurrence

of tubercular lesions in the areas drained into the glands, and lessened phagocytic power of the lymphocytes or less resisting power of the tissues to the life and growth of the tubercle bacilli. Bacilli may be inhaled or taken in with the food, particularly in milk. Catarrh of the nose, pharynx, and mouth leads to shedding of the surface-epithelium, and so facilitates the entrance of the bacilli into the tissues. Ulceration of the tonsils and pharynx or of the gums around carious teeth has the same effect. Bad air, insufficient food, overwork, depressing emotions, infantile and other diseases, and possibly an inherited taint lessen the resisting power of the tissues to tubercle bacilli. The tissues of children, adolescents, and young adults are much less resistant than are those of middle-aged and older persons. Tubercular disease of the tonsils is probably more common than has been hitherto recognized, and it may be an important source of infection of the glands. Lesions of the skin, such as occur in pediculi capitis, eczema, impetigo, and wounds, may also be the door of entrance for tubercle bacilli. It seems certain that non-tubercular lesions may be the occasion of tubercular infection, the bacilli gaining entrance through them and being carried in the lymphocytes along the lymphatics into the glands, and there multiplying and producing their specific effects.

Tubercular disease of the cervical glands is the commonest of tubercular lesions, and this is explained partly by the frequent, if not constant, presence of tubercle bacilli on the surfaces drained into these glands, and partly by the great frequency of catarrhal and other lesions of these surfaces, which both facilitate the ingress of the bacilli and lessen the anti-bacillary function of the tissues, both at the surface and in the glands. The exposure of the glands to changes of temperature and to the disturbing influence of movement has been supposed to have some slight prejudicial effect.

This disease is met with chiefly in the first half of life, occasionally in quite young infants; it becomes very frequent in childhood and adolescence, and then less frequent toward thirty years of age. It is particularly common among the children of the poor, and especially in the dwellers in ill-drained, ill-ventilated, low-lying, overcrowded quarters, and in the convalescents from diphtheria, measles, scarlatina, and whooping-cough.

Pathology.—For the minute pathology of tubercle, see Vol. I., p. 236. Here it is necessary to notice especially the caseation and calcification of the glands, the inflammation around the glands fixing them to muscles, vessels, nerves, and other structures, the softening and abscess that very often ensue, and the spread of the disease from gland to gland. Caseation is an invariable event, but it varies in extent, in some cases causing yellow spots and streaks in the section of a gland, and in others producing caseation of the entire contents of the gland-capsule. Calcification is less common, and, as a rule, less extensive, but an entire gland may be converted into a hard mass of lime salts. I have removed glands as hard as fruit-stones. The inflammation around the tubercular glands is a very important feature. Not only does it obscure the clear outline of the gland itself, but it fixes it to the surrounding tissues and often renders the enucleation of the gland a very troublesome process. The extent of this inflammation

varies within rather wide limits; it is always more than appears on external examination of the gland. Muscles and veins are the structures found to be most closely adherent to the glands, and it is at times impossible to separate a gland from the internal jugular vein.

Softening of the tubercular products is a very frequent result. For a time the débris is confined within the thickened capsule of the gland; but as the process advances the capsule is perforated, and a tubercular abscess forms outside the gland and spreads toward the surface, ultimately bursting. This is an extension of the tubercular process. The abscess outside the gland is not the result of the discharge of tubercular débris from the gland, but of the infection of the periglandular tissue by the tubercle bacillus. The wall of the superficial abscess is formed of a soft layer of tubercular granulation-tissue in which caseation can always be recognized. A double infection—tubercular and pyogenic—may occur, and this greatly adds to the acuteness and severity of the process.

The disease has a marked tendency to spread from gland to gland, but the rapidity with which this occurs and its extent vary. In some cases it is limited to one gland or one small group of glands for many months; and, on the other hand, cases are met with in which gland after gland on each side of the neck is attacked with a rapidity and severity that justify the use of the term acute, and are not surpassed even in the case of malignant disease.

Symptoms and Diagnosis.—The special features of the tubercular enlargement of a gland are its chronic course, the occurrence of softening, and the infective nature of the disease, as shown by its spreading from gland to gland. In some instances one or even two of these features may be absent when the case is first seen. The diseased glands are always swollen, and, until softening has occurred, firmer than natural, ovoid in shape, generally painless, and more or less fixed to the surrounding tissues. The outline of the gland may be entirely obscured by the surrounding inflammation; but, on the other hand, the gland may appear to move quite freely over muscles, fasciæ, and bones. As the glands soften they become more globular in outline, and when a tubercular abscess has formed outside the gland, the swelling is increased, bulges on the surface, fluctuates, and later on points and bursts. The skin over the part is not discolored until pointing occurs, and then it becomes reddened and very thin over the whole abscess; and this very thin skin usually breaks down, so that the resulting scar is large and unsightly. As a rule, there is no pain, merely slight discomfort; but sometimes patients complain a good deal of both pain and tenderness. The onset of the affection varies; it may be quite insidious, attention being accidentally drawn to the painless swelling. In other cases the onset is more defined, or even abrupt, being connected with an attack of measles, scarlatina, diphtheria, whooping-cough, tonsillitis, or a common cold. The course of the disease varies as much as the onset. The typical course is a slow increase of the swelling, a stealthy spread from gland to gland, and a gradual softening of the swelling. In many cases, having reached a certain size, the glands undergo no further increase. The disease may be limited to a single gland, although this is quite rare, or to two or three glands only, and show

no tendency to spread beyond the glands first affected. In the same way, softening may occur very early or be absent altogether. Cases are sometimes met with where the course of the disease is very rapid, gland after gland is attacked, grows to a considerable size, and quickly softens. The issue of these very acute cases is bad. Sometimes glands which cannot be clinically distinguished from tubercular glands resolve entirely and return to the normal.

The general condition of the patients is, as a rule, unsatisfactory. They are thin and pale, with more or less real anemia and debility; the temperature is raised in the acute cases and when pus-infection is added to tubercle. Some patients, however, show no departure from the normal state of health.

The **diagnosis** rests upon the persistence of the glandular enlargement, the absence of acute inflammatory signs, the evidence of periadenitis fixing the gland, the softening of the swelling, the number of the glands affected, and the age and general condition of the patient— sometimes also upon the existence of other tubercular affections in the same individual. These signs of tubercle are stated in their order of relative frequency and importance.

Prognosis.—Some cases of tubercular glands become quite well; others persist as masses of inert and innocuous lime salts, or as dry cheesy matter within a thick fibrous capsule, causing no local trouble, but being a possible source of infection of other parts of the body— meninges, bones, or lungs. Others steadily progress to softening and external discharge, and the sinuses thus formed after months or years heal up, leaving large puckered and unsightly scars. While in a large number of patients with tubercular glands no other tubercular lesions develop, the cases in which tubercle of the brain or membranes or of the bones or lungs subsequently arises are too numerous to warrant a disregard of the possibility of this event.

Treatment.—In the early stage of the disease, and before softening has occurred, palliative treatment should, wherever possible, be carefully applied. This should consist in a prolonged stay at the seaside or on a high moor, or a sea voyage; the diet should be nutritious, chiefly animal with plenty of fat; all milk should be boiled; tonics such as cod-liver oil, iron, arsenic, and strychnin should be given. In some cases iodin, potassium iodid, or thyroid extract seems to do good. A soft flannel bandage should be applied to the neck. If the glands enlarge rapidly, they should be protected and soothed by hot fomentations or a dry flannel bandage. At the same time any lesions on the skin or mucous membrane of the head and neck should be carefully treated.

Where this treatment has failed, or whenever softening has occurred, the question of radical surgical treatment must be carefully considered. The justification of surgical interference is twofold. In the first place it effects, or is intended to effect, the removal from the body of a possible source of infection; in the second place it accomplishes quickly, painlessly, and with the minimum of scar what nature effects very slowly and with the sequel of ugly scarring. The marked improvement in the general health that often follows the complete eradication of tubercular glands is another reason in support of operation. On

the other hand, it may be urged that the operation itself may dissemi-
nate the tubercle bacilli; that there is a great probability that the sur-
geon will fail to remove all the infected glands; that to leave one
tubercular gland behind exposes the patient to the risk of infection of
his own tissues; and that, even if all diseased glands are removed, the
exposure to infection with tubercle bacilli is so constant that new
fresh infection from without will almost certainly occur in one pre-
disposed to this disease.   Some have urged that tubercular disease
of the glands may actually protect the patient against visceral tubercu-
losis.   There is no evidence to support this view, but the other objec-
tions to surgical treatment have something in them.   Many cases have
been recorded where the signs of tubercular meningitis have quickly
followed upon an operation on a tubercular gland, particularly scraping.
The cases are too many for this to be a mere coincidence.

At the present time two operations are employed—scraping and
excision.

Scraping is especially adapted to cases of abscess outside a tuber-
cular gland; it can also be employed satisfactorily in a softened tuber-
cular gland.   A small incision is made directly into the softened
tubercular matter, and the more fluid parts are removed by gentle
pressure.   With a blunt spoon all the remaining tubercular tissue is
removed.   This must be done systematically and very thoroughly, care
being taken to remove as well as to detach all the diseased and infected
parts.   When there is a superficial abscess, the wall of this should first
of all be scraped away, and then the communication with the deeper
lying diseased gland must be found, the spoon introduced through it,
and the entire contents of the gland-capsule evacuated.   The scraping
should be followed by the application of an efficient germicide.   Chlorid
of zinc, 40 grs. to the oz., is the best; sterilized iodoform is also largely
used.   The cavity should then be lightly stuffed with iodoform gauze
for forty-eight hours and allowed to heal up by adhesion of the opposed
surfaces.

The advantages of this operation are its simplicity, immediate safety,
and the small scar it leaves.   The surgeon needs no assistant and only
two or three instruments; the hemorrhage is quite insignificant and the
shock slight, and in many cases the tiny skin-wound heals very quickly
and leaves a scarcely perceptible scar.   There is no danger of scraping
through the capsule of a gland and wounding veins, arteries, or nerves
adherent to it.   Provided, therefore, that the gland is entered without
puncture of any important part, its evacuation is unattended with risk.

The disadvantages of this operation are its uncertainty of cure, its
limitation, and its risk of dissemination of tubercle.   It is not easy to
scrape away every portion of infected tissue by means of a spoon intro-
duced through a small aperture.   The frank recognition of this diffi-
culty is the best help toward overcoming it, as it makes the operator
very thorough in his scraping and careful to go systematically over the
ground at least twice.   Special care must be taken, too, not to leave
behind detached fragments of infected tissue which may light up the
disease again.

It often happens that there are other smaller diseased glands close
to the larger gland connected with a superficial abscess.   Scraping does

not deal with them, so that when the wound has healed, a new glandular swelling appears in its immediate neighborhood. Deep-lying glands are not safely dealt with by puncture and scraping, and the method is not well adapted to the treatment of other than caseated and softened tubercular glands. Facts seem to show that scraping operations are more liable to be followed by dissemination of tubercle than is excision of a gland. It is thought that this is due to the action of the spoon pressing tubercle bacilli into open vessels or fine fissures in the tissues.

Excision can be employed in very nearly all cases of tubercular glands. An incision is made down to the capsule of the gland, and then with the knife or a blunt dissector the surrounding tissues are separated from the gland and the latter removed. Care is taken not to perforate or burst the capsule, lest the tubercular débris infect the surface of the wound; one must keep close to the gland-capsule, so as not to wound veins, arteries, or nerves. Search should be made in the wound for other glands than those originally detected; it is often remarkable how many diseased glands are removed where only a few have been previously thought to exist. All the glands found diseased, or even· suspected to be diseased, should be removed. It sometimes happens that a gland, or a part of one, is so firmly incorporated with the internal jugular vein or some other important structure that the two cannot be separated. In that case, as much as possible should be excised and the rest very thoroughly scraped. The same course has to be pursued in the case of tubercular glands in the parotid.

If the operation has been completed without the escape of any tubercular matter into the wound, the latter may be at once closed and sealed with a collodion or other suitable dressing. If tubercular matter has been discharged over the surface of the wound, it should be well treated with chlorid-of-zinc solution (40 grs. to the oz.) or sterilized iodoform before it is sutured. In neither case is drainage needed or desirable, if all hemorrhage has been carefully arrested, as it should be. If all is well, primary union with a linear scar is secured, the periglandular and traumatic induration disappears, and only the scar marks the site of the old disease.

Two or three methods of operating have been recommended. One is to make a short incision over each diseased gland, each incision being so placed as to avoid wounding vessels and nerves and to obtain the least scarring. This necessitates many separate wounds and gives poor exposure for dissection. A better method is to make one, two, or three long incisions, perhaps, on each side of the neck. Thus, one incision is made along the anterior border of the sternomastoid muscle, a second along the posterior border of the same muscle or along the external jugular vein, and a third along the body of the mandible. The advantages of this method are the very complete exposure of the glands, the readiness with which all the diseased glands are found, and the greater ease with which the large vessels and nerves can be preserved from injury. The disadvantage of the method is the long, unsightly scar or scars it occasions. A third method is the employment of one, two, or three limited and specially placed incisions. The most useful incision is one from the tip of the mastoid process to the cornu of the hyoid bone. When the diseased glands beneath this have been

removed, others below, behind, or in front of it can be brought into the wound by drawing aside its border, pushing up the gland from outside, or by the careful use of the finger or blunt dissector within the wound. By practice and patience the entire chain of glands along the internal jugular vein can be removed through this incision, as well as some, if not all, of the submaxillary glands. A second very useful incision is a short transverse one exposing the posterior border of the sternomastoid muscle about $1\frac{1}{2}$ inches above the clavicle. Through this the glands along the external jugular vein, those in the posterior triangle, and the lowest of the deep cervical glands can be removed. A third incision

FIG. 79.—Showing incisions for various operations : 1, for angina Ludovici ; 2, for thyroidectomy ; 3, 4, 5, for excisions of tuberculous glands.

is sometimes required to remove submental glands (Fig. 79, 3, 4, 5). This is the method to be recommended to more experienced operators. The scars are short ; and if the wounds are well placed, well sutured, and heal by " first intention," they are not conspicuous and may become almost imperceptible. Too much care cannot be taken in the exact adjustment of the wound-surfaces and edges.

The advantages of the operation of excision are its extended applicability, its thoroughness, and the small risk of dissemination of tubercle. There are no cases which cannot be dealt with by excision. The surgeon sees and feels what he is doing, and ought not to overlook and leave behind diseased glands ; and if he removes the glands entire, the danger of introducing bacilli into the circulation appears to be nil.

The disadvantages of this operation are its difficulty, its severity, the danger of wounding important vessels and nerves, the length of time occupied, and the unsightliness of the resulting scars. If many glands are affected, and if there is much peri-adenitis, the operation is long, difficult, and severe. It is not an operation that can be hurried ; for hurry leads not only to wound of vessels and nerves and to rupture of softened glands, but also to the overlooking of diseased glands. The operator must at almost all cost remove every diseased gland, and that without wound of important vessels and nerves. Should they be divided, the vessels must be carefully ligatured and the nerves sutured. With care a great deal can be done to lessen the extent and the conspicuousness of the scars.

In conclusion, I would recommend this as the operation of choice for tubercular glands. The larger my experience in it the more reason

have I had to be well satisfied with it. Occasionally the operation has to be repeated for other groups of glands or other members of the same group.

In neglected cases, where the abscess has been allowed to burst and a tubercular ulcer or sinus remains, a careful scraping operation is all that is required. In some cases, too, where the spoon has been used in the first instance and a sinus remains because of the failure to remove all the infected tissue, a second use of the spoon will be quickly successful.

Syphilitic Disease of Cervical Glands.—During the early secondary stage of syphilis the cervical glands are liable to enlarge. The swelling is usually only slight and unattended with pain, tenderness, or redness of the covering skin; there is no inflammation around the glands, and suppuration does not occur. All the glands in the neck may be affected, or only one or two groups. The enlargement is most often seen in those behind the sternomastoid muscle and beneath the occiput, and it is stated that the disease always involves all the members of any group attacked. The glands may be swollen without any syphilitic lesion of the area draining into them; but, as a rule, those glands only are enlarged which receive lymph from surfaces that are the seat of well-marked secondary eruptions.

No special **treatment** of these glands is called for; under the general treatment of secondary syphilis they gradually subside.

Lymphoma.—A true hypertrophy of lymphatic gland is sometimes met with—an increase of the normal structure associated with increased function.

The disease called lymphoma is characterized by an overgrowth of gland, but there is nothing to show that this is associated with increased function. The disease is rare and its origin obscure. It attacks one or two glands only, and these slowly enlarge without pain or other symptom, and having attained a certain size may remain stationary for an indefinite time.

Lymphoma occurs in young people, and is generally associated with anemia. These two facts make it liable to be confounded with tubercle. The distinguishing features are the entire absence of periadenitis and of softening of the gland; often the large size of the tumor aids in the diagnosis.

Treatment.—A course of arsenic combined with "thyroid feeding," with a trip to the seaside, should be first tried. If this fails, and the enlarged gland is unsightly or continuously enlarging, it should be removed. This is a very simple operation, as the tumor is easily shelled out from its bed of loose cellular tissue.

Sarcoma.—The lymphatic glands are occasionally the seat of a primary malignant growth composed of small round cells embedded in a very fine wide-meshed stroma. This is a form of sarcoma. Nothing is definitely known of its cause. It is not a common disease, and is met with in adults at or past middle life. The disease attacks a single gland, which rapidly and continuously enlarges. In its earliest stages the tumor is not to be distinguished from a lymphoma or a tubercular gland, but its rapid growth and the infiltration of tissues around the gland soon make its nature evident. The disease spreads beyond the gland itself and infiltrates fasciæ and muscles, and, as it

grows, it displaces, compresses, and may destroy vessels and nerves and seriously press upon the trachea and esophagus. The tumor may reach a great size, and when the skin over it ulcerates, the mass fungates, adding considerably to the patient's distress. In the early stage of the growth there is no pain; but as the nerves in its neighborhood become involved the pain becomes severe, radiating over the head and down the arm. Pressure upon the cervical sympathetic causes first a dilated pupil, and later on a small pupil.

Secondary growths occur, chiefly in the lungs and mediastinum. The patient dies worn out by pain and weakened by discharge and inability to take food, and in some cases pressure upon the trachea hastens the end.

Treatment.—If the disease is recognized in its early stage, before the gland has become at all fixed in its bed of cellular tissue, it should be removed with as much cellular tissue around as possible. Later on, however, operation is useless, and is to be deprecated. The disease is very rarely diagnosed before its infiltrating character is evident, and an operation undertaken at this period is both very grave in itself and certain to be followed by speedy recurrence. Anodynes and narcotics must be given to relieve pain, and other symptoms should be treated as they arise. Coley's fluid may be injected in these cases, but experience in this treatment is as yet too indefinite to warrant any strong recommendation of it.

Carcinoma.—Carcinoma very rarely occurs primarily in the neck, starting there from some obscure embryonic epithelial structure; but it occurs very often in the cervical glands, as a secondary growth. In the form of epithelioma it is met with as a sequel to epithelioma of the lips, tongue, jaws, tonsil, palate, larynx, and esophagus. Spheroidal carcinoma of cervical glands occurs in cases of cancer of the thyroid and cancer of the breast. As in cancer generally, great variation is met with in the course of the disease in the glands. As a rule, the growth is rapid and continuous, and gland after gland is affected in the course of the lymph-stream; but in some rare cases the growth is very slow, and I have known it not only to be arrested for a time, but actually to disappear. On the other hand, other glands than those in the course of the lymph-stream may be infected. For instance, in carcinoma of the breast, after the axillary glands, those in the posterior triangle of the neck and one gland under the sternomastoid close above the inner end of the clavicle are those usually involved in the lymphatic spread of the disease. I have, however, seen a case of this disease in which not only these glands, but many higher in the neck, along the external jugular vein and under the sternomastoid, were affected on both sides. Cancerous glands are at first firm, even hard, in consistence, but later they may soften down, burst externally, and then ulcerate, forming deep fungating chasms, and finally prove fatal by ulcerating into a large vessel, generally a vein. There is one feature of this disease, as seen in glands, which seems to be absolutely constant, and that is its infiltrating the tissues around the glands. In the early stages the gland is movable, but it soon becomes fixed, and the malignant growth extends beyond the capsule of the gland into fascia, muscles, vessels, nerves, and skin.

Allowing, then, for this rather wide variation in the course of cancer in glands, we may say that the disease causes a progressive enlargement of one or more glands; that the tumors thus formed may be small, painless, and unnoticed by the patient for a long time; but that more generally they increase into obvious or even large swellings, fixed to neighboring parts, and are the seat of a constant dull aching pain, as well as the cause of paroxysms of severe lancinating pain along the course of the nerves compressed. Pressure upon veins may be attended by serious engorgement and edema of the parts beyond, and the obstruction to the lymph-stream adds to this edema. Occasionally pressure upon the trachea or esophagus causes dyspnea and dysphagia. In cancer of the supraclavicular glands, edema of the arms and severe pains all down the limb are very often observed. In cancer of the higher cervical glands, edema of the face is occasionally seen, and severe pain along the course of the occipital and auriculotemporal nerves is very often complained of. The diseased glands become immovably fixed to surrounding parts; the skin often becomes involved, and in the harder forms it may be puckered in. If the tumor softens, the swelling increases more rapidly, fluctuates, points, and then bursts through the reddened skin if it is not previously opened by the surgeon—sometimes under the impression that an abscess has formed. The matter discharged is a pultaceous fluid, chiefly composed of granules and flakes or larger masses of broken-down epitheliomatous growth. After the bursting, which usually relieves the pain for a time, the opening generally ulcerates, in some cases with fearful rapidity, forming a very deep, widely excavated ulcer, with a fungating and partly sloughing surface discharging a stinking, opaque, serous fluid in great quantity. From this surface hemorrhage may occur from time to time and rapidly exhaust the already enfeebled patient; a large vein or artery may be opened up and a profuse and fatal hemorrhage result. In rarer cases the opening into the softened gland remains as a small sinus. I have known such an opening to be surrounded by healthy non-malignant granulations.

Prognosis.—The prognosis of cancer of the cervical glands is very grave. As a rule, the disease is more active and more malignant and less amenable to treatment in the glands than in the primary seat of the disease. When the glands soften and ulcerate deeply, death always occurs quickly. In some cases secondary to cancer of the breast, the affection of the cervical glands seems to have very little influence upon the course of the case.

Treatment.—The excision of cancerous glands is a very unsatisfactory operation. The disease has generally spread farther along the lymphatic system than is apparent at the operation, and it has also usually infected the tissues around the gland to an extent imperceptible to the naked eye, so that speedy recurrence *in loco* or in a neighboring gland almost always follows the operation. The glands, too, lie close to large vessels, nerves, and other important structures, and the free removal of a diseased gland exposes the patient to the risk of injury of these parts, or their deliberate division or even excision at once renders the procedure a very grave one.

Operation is sometimes quite successful, and secures either complete

or prolonged immunity from the disease. The circumstances which justify operation are slow growth and small size of the tumor, showing a low degree of malignancy, free mobility of the tumor, and the fact that the glands on the proximal side of the growth are neither enlarged nor hard. Under these conditions, if the operation is carried out with care and thoroughness, it is permissible and may be recommended. Success has been attained in some very unpromising cases, but more often the surgeon finds the growth more extensive and more widely infiltrating than he had anticipated, and has either to abandon the operation uncompleted or to witness an immediate return of the disease, perhaps more active than before. Two good rules to remember are: (1) that secondary glandular epithelioma is more malignant, and therefore more difficult to deal with by operation, than is the primary disease; and (2) that the disease is always found to be more extensive and more difficult to remove than the most careful preliminary examination has rendered apparent.

In the greater number of cases no operation should be performed. Hot fomentations, poultices, and all irritant external applications are to be carefully avoided; they seem to add to the trouble. The extract of belladonna smeared on lint and laid over the part sometimes relieves pain; an ointment of equal parts of the extracts of henbane, conium, and belladonna often affords marked relief. The extract of opium or the tincture of opium on spongiopilin relieves pain. The severe neuralgic pains can usually be relieved by phenacetin, and a patient trial of this drug should be made before a resort to opium and morphin.

When a cancerous gland has softened, as a rule nothing should be done to assist its opening; but if it is the seat of severe and constant pain, great relief is to be obtained by its puncture and the relief of tension. An absorbent antiseptic dressing must be applied over the wound.

The large fungating cancerous ulcers must be kept as clean as possible. A lotion of izal or creolin often succeeds in deodorizing the part and in lessening discharge; iodoform and other antiseptics may be employed. Slight oozing of blood from the ulcer can be checked by sprinkling finely powdered sulphate of iron over the surface. If severe hemorrhage occurs, it is not justifiable to undertake any formal operation for its arrest, such as the ligature of a large vessel, but careful local pressure may be resorted to. This "accident" affords a rapid and merciful termination of the patient's hopeless sufferings.

In some cases these malignant growths cause severe dyspnea by pressure on the trachea, and the question of tracheotomy will then arise. The operation rarely affords any relief; but if the circumstances of any particular case point to this operation as offering a reasonable prospect of relief, the surgeon should provide himself with a long tube to be passed some distance down the windpipe past the compressing glands.

INJURIES AND DISEASES OF THE LARYNX AND TRACHEA.

Injuries of the Larynx and Trachea.—In the section on Contusions of the Neck (p. 106), fractures of the hyoid bone, laryngeal cartilages, and rupture of the trachea have been dealt with. For Wounds of the Larynx and Trachea see p. 107.

Scald of the larynx is unfortunately a rather common accident among the children of the poor; it is caused by the child drinking from the spout of a kettle or tea-pot. More or less scalding of the mouth occurs, with swelling and hyperemia of the mucous membrane, or destruction of the epithelium or deeper sloughing. In the larynx the effect of the scald is a rapid edema of the loose cellular tissue about its upper aperture. This leads to dyspnea and loss of voice, and death very often occurs either suddenly or by a gradual increase in the respiratory obstruction.

Treatment must be prompt. In the slightest cases it is sufficient to apply a hot compress to the neck, to sit the child up in bed, and to have it constantly watched. When the signs of respiratory obstruction are at all marked, active measures should be at once taken to relieve it. The surgeon has three measures from which to choose. He may scarify the edematous folds and administer a spray of cocain—this is difficult in very young children and unsatisfactory. He may resort to intubation of the larynx or to tracheotomy.

Foreign Bodies in the Larynx, Trachea, and Bronchi.—Foreign bodies gain access to the air-passages by a sudden inspiration occurring while something is in the mouth or pharynx. In this way portions of food or of vomited matters, coins, pins, beads, nuts, fruit-stones, buttons, studs, teeth, grass-heads, puffs, and various other articles have been drawn into the air-passages. Part of a cannula has been known to break off and drop into the trachea through a tracheotomy wound.

The cases in which blood, discharges of various kinds, portions of malignant growths, or of a softened tubercular gland pass into the air-passages belong to a different category and are not considered here.

A foreign body passes into the right bronchus more frequently than the left, owing to its larger size and its being more in a line with the trachea.

Effects.—The foreign body may be immediately ejected without any other effect than a momentary sense of suffocation and a paroxysm of coughing, or it may cause immediate death from

Fig. 80.—Bean completely filling the right bronchus. Girl aged two years. Death in thirty hours. Lungs solidified (Warren Museum).

impaction in the glottis and spasm. More often it becomes fixed in the larynx or drawn into one of the bronchi (Fig. 80). Occasionally it remains loose in the trachea for a while, rising into the larynx and exciting violent coughing and spasm, then falling into a bronchus.

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Later on it may become fixed in either of these situations.   Or a foreign body that has been at first impacted in the larynx may become detached and pass into a bronchus, or *vice versâ ;* or one that has been primarily drawn into a bronchus may after a time be dislodged, but fail to pass through the larynx and remain impacted there.   Lastly, fortunate cases do occur in which some time after impaction in either larynx or bronchus the foreign body may be expelled through the larynx and either swallowed or coughed out through the mouth.

FIG. 81.—*A,* foreign body (piece of nutshell) in the larynx; *B,* papilloma of the larynx; *C,* salivary calculus (drawn from specimens in the Middlesex Hospital Museum).

As a rule, the foreign body sets up inflammation and then ulceration in the tissues around it, leading in the larynx to great swelling, possibly œdema glottidis, suppuration, and necrosis of cartilage.   The lodgement of a foreign body in a bronchus is a very grave accident, leading to serious changes in the lung.   These begin with septic bronchitis; then follows pneumonia, which in some cases ends in gangrene, in others in burrowing suppuration which may reach the surface and form a means of exit for the foreign body, but most often it results in bronchiectasis.   This, when once set up, may involve the tubes in a considerable area of the lung.   These changes are rapid and intense when the foreign body is sharp and irritating, like a head of grass, but may be very slow when it is smooth and rounded.   When once these changes have occurred, they are often irreparable, and it is therefore most important to remove all foreign bodies in bronchi at the earliest possible moment, without waiting for symptoms or evidence of mischief.

Symptoms.—At the first entrance of the foreign body there is generally a painful paroxysm of choking and coughing, and the voice may be altered or altogether lost.   This may be followed by subsidence of all symptoms, suggesting that after all nothing serious has happened, and this misleading calm may last for hours, days, or even

longer. When lodged in the larynx, there is usually local pain, with alteration in the voice, paroxysmal cough, and dyspnea, and these are increased by the swelling that comes on later. With the laryngoscope the body can usually be seen lying either above or below the vocal cords. The symptoms vary with the size, shape, and position of the body. When in the trachea the patient may be conscious of its rise and fall in the tube with each respiration. On listening over the tube a loud rhonchus may be heard, and on taking a deep expiration a severe cough with violent dyspnea results from the body rising and striking the irritable larynx. When in a bronchus, the symptoms vary with its size and shape. If a smooth, rounded body, such as a fruit-stone, plugs a main bronchus, there is sometimes pain felt just over the spot, the patient has dyspnea on exertion, and attacks of paroxysmal coughing. That side of the chest is found to be immobile, with grad-ually increasing dulness and absence of breath-sound, and of tactile and vocal vibration over the lung, while exaggerated breathing is heard over the opposite lung. If the foreign body does not quite block the bronchus, and lets some air pass to and fro, a loud rhonchus is heard over the seat of impaction, conducted more or less over the whole lung. Such a body as a smooth tracheotomy tube lying in a bronchus may be very difficult to recognize, as it offers little or no obstruction to the passage of air. If the body is so small that it passes into a secondary, tertiary, or smaller bronchial tube, the symp-toms are less severe and the physical signs—dulness, imperfect entry of air, and rhonchus—are limited to the part of the lung involved. Later on, when the secondary lung-changes are set up, fever, wasting, purulent expectoration, hemoptysis, and great fetor of breath are complained of, and examination of the chest shows the usual signs of gangrene of the lung or of bronchiectasis.

It is very important to remember that all subjective symptoms of a foreign body may subside for even a long time, and that the objective signs may be very few and very difficult to determine. Some foreign bodies can be localized by the Röntgen rays.

Treatment.—In every case the foreign body must be extracted at the earliest possible moment, irrespective of its nature, position, or symptoms.

In the Larynx.—In the first instance the finger should be passed to the upper opening of the larynx to feel and dislodge any foreign body there. If it can be seen with the laryngoscope, it may be possi-ble to remove it with laryngeal forceps, guided by the mirror. Cocain should be previously applied to the pharynx and larynx to facilitate this measure. If this is impossible, the surgeon has to choose between thyrotomy, laryngotomy, and tracheotomy, and the age of the patient and the position and shape of the body will guide him in his choice. The removal must be effected with the least possible injury to the larynx.

If the foreign body is *in the trachea*, that tube should be opened at once, when the body will usually be expelled, or can be removed with forceps. If the surgeon has every preparation made for an immediate tracheotomy, he may try whether, by inverting the patient and shaking him or patting his back, the foreign body can be expelled through

the larynx. This should never be done unless the surgeon is thus prepared, lest it become lodged in the glottis and cause immediate death.

In a Bronchus.—Tracheotomy with a free incision of the trachea should be done at once, and if the body is not expelled by the patient's coughing (often through the larynx), careful efforts to remove it by suitable forceps, snares, or bent wires must be made, or the patient may be inverted and shaken (only *after* tracheotomy). If all such efforts fail, the tracheal wound must be held agape by silk threads passed through each side and tied round the neck, and the patient watched, and after a time a new attempt may be more successful.

When suppuration in the lung has occurred, the abscess or bronchiectatic cavity must be opened through the chest-wall and carefully explored with finger, probe, or forceps, and a large-sized drainage-tube inserted. If, as usually happens, the foreign body is not found and removed by the surgeon, it may escape some time after through the tube. If this does not occur, tracheotomy should be done and the bronchial tubes must be explored from above. No effort must be spared to extract the foreign body, and before secondary changes have been set up in the lung. When these changes are advanced, operation rarely leads to cure.

Laryngitis.—Laryngitis occurs under two chief forms, acute and chronic, and each of them has certain varieties.

Acute catarrhal laryngitis may be excited by over-use of the voice, by exposure to cold, by excessive use of alcohol or tobacco, by the inhalation of irritating vapors or contact with corrosives, by operations upon the larynx, and by extension of the diseased process from the pharynx. A previous attack predisposes the patient to a subsequent one.

The *symptoms* are a certain amount of local soreness and "roughness" of the throat; cough, which is apt to come on in long, exhausting paroxysms; and hoarseness, which may amount to aphonia. When the epiglottis is inflamed, there is pain in swallowing. The temperature is a little raised, and there may be a sense of chilliness at the onset of the attack. The larynx is seen to be hyperemic, with slight swelling of the inflamed mucous membrane. The cords are nearly always affected; in severe cases their mobility may be diminished.

Acute Hemorrhagic Laryngitis.—This name has been applied to certain cases in which there is hemoptysis; minute bleeding points can be seen with the laryngoscope.

Acute edematous laryngitis is a very grave disease. It is a septic disease, and is in many cases due to infection with erysipelas. Fehleisen's coccus has been demonstrated to be present in some cases. The special feature of the disease is its rapid course, with the production of great edema in the loose submucous tissue, so that the aryteno-epiglottidean folds, the interarytenoid fold, and the epiglottis become greatly swelled; in some cases the edema is limited to the parts below the glottis (subglottic edema). The swelling causes urgent dyspnea and cyanosis, which often come on in paroxysms of extreme distress, any one of which may be fatal. The swelling can be seen with the laryngoscope; often it can be plainly felt with the finger. There is

usually swelling of the pharynx and of the soft parts around the larynx, and suppuration in the neck may ensue. The temperature is raised, the tongue is very foul, the pulse is rapid and soft, and the general condition is very apt to pass into the "typhoid state" and the patient to die with a "low" pneumonia, if he escapes suffocation. The disease is met with most often in subjects of intemperate habits or of renal disease; it is very fatal.

Treatment.—In the catarrhal form the patient should be kept in bed and forbidden to use his voice. Ice may be given and applied externally over the larynx. In some cases inhalations of steam, to which eucalyptus, thymol, pinol, or benzoin has been added, or of the chlorid-of-ammonium vapor afford far more relief than the cold application. For the hemorrhagic form an astringent spray is indicated; a solution of perchlorid of iron, gr. 3 to 1 oz., is a good form. Edematous laryngitis demands prompt and energetic treatment. Leeches should be applied over the larynx, and then ice; ice should be constantly sucked, the bowels should be freely opened, and at the same time the patient's strength must be supported by nourishing diet. Alcohol is usually given. The patient must never be left alone, as urgent dyspnea may at any time supervene. This may be relieved by local scarification, or, better, by laryngotomy or tracheotomy. Abscesses occurring round the larynx must be opened freely as soon as their presence is recognized.

Œdema glottidis is a very grave condition. It arises from several causes, and, if not at once relieved, quickly proves fatal by asphyxia. The acute swelling may result from injuries—fracture of the cartilages and the like, wounds, scalds, local application of irritants, either accidental or remedial, and operations. It results from septic and erysipelatous laryngitis, and also sometimes from extension of surrounding inflammation in scarlatina, angina Ludovici, or deep cervical abscesses; it may occur in the course of tubercular or syphilitic disease of the larynx, and lastly, it may be a passive edema in Bright's disease or result from the pressure of a tumor upon the internal jugular vein.

The *symptoms* often come on with alarming suddenness, the patient sitting up in bed, manifesting great distress, and breathing with difficulty. Inspiration and expiration are equally obstructed, and the voice is lost.

Treatment.—A cocain spray is useful in the slighter forms of the disease. Free scarification of the edematous tissues, either with a laryngeal lancet or a sharp-pointed curved bistoury protected to within $\frac{1}{2}$ inch of its point, may relieve the swelling. If not, and in all cases of great urgency, laryngotomy or tracheotomy must be performed. Tracheotomy should be preferred in all cases in children, and in septic laryngitis and tubercular and syphilitic disease in adults. In other cases laryngotomy is to be preferred.

Chronic laryngitis is met with as a sequel to an acute attack or as the result of over-use of the voice—as in costermongers and street-criers and some public speakers and vocalists—or of excess in alcohol and tobacco. It leads to slight swelling and redness of the mucous membrane, with a little thickening; there may be slight erosion of the epithelium, but ulceration does not occur. In some cases small, dry

crusts of mucus are seen adhering to the vocal cords (*laryngitis sicca*). In other cases the chief change is an excessive secretion of mucus whenever the voice is used. This is met with in vocalists; the condition is called *laryngorrhea*. The disease induces hoarseness and loss of voice in varying degrees, and a dry, tickling sensation, leading to cough and a constant desire to clear the throat.

Treatment.—The voice must be rested. Much may often be done by attention to the general health—*e. g.*, by a sea-voyage or a change to a dry climate, and by abstinence from alcohol and tobacco. Locally the treatment consists in the application of astringents either by spray or brush.

Perichondritis of the Larynx.—Inflammation of the perichondrium very rarely occurs as a primary disease; it is nearly always secondary to tubercular, syphilitic, typhoid, or cancerous ulcers of the larynx, or to injury. It is stated that the pressure of the posterior part of the cricoid cartilage against the spine in very debilitated subjects, and the frequent passage of an esophageal bougie, may so injure the perichondrium as to cause it to become inflamed. The disease attacks the cricoid and arytenoid cartilages much more often than the thyroid. It leads to necrosis of the cartilage involved, and is attended with considerable swelling of the part, fixation of the arytenoid cartilage, and deep suppuration discharging either into the larynx, pharynx, or externally. If the patient survives the earlier dangers, severe stenosis is liable to follow, necessitating the permanent wearing of a tracheal tube.

Treatment.—Tracheotomy is often necessary for the relief of the dyspnea due to laryngeal swelling, as well as for resulting stenosis. Abscesses may require opening, and sometimes a portion of necrosed cartilage can be removed with great benefit.

Syphilitic Disease of the Larynx and Trachea.—In the secondary stage of syphilis, catarrh, mucous plaques, and superficial ulceration may be met with both in the larynx and in the trachea. They are rare, and readily yield to the constitutional treatment of the disease by mercury.

In the tertiary stage of the disease, gummatous infiltration, rapidly breaking down into ulcers and leaving firm, fibrous, puckered cicatrices, occurs in both larynx and trachea. In the larynx the upper surface of the epiglottis is the part most often attacked; ulceration is rapid and deep, portions of the cartilage may exfoliate, and great contraction and deformity of the upper orifice of the larynx may result from the cicatrization of the ulcer. In the trachea the disease occurs most often in the lower part, although it may be met with at any part, or be widely diffused. Great stenosis, with dilatation above and below the stricture, may result from the contraction of the ulcers.

Symptoms.—The symptoms of the laryngeal disease are pain, dyspnea, cough, aphonia, and dysphagia. With the laryngoscope the deep ulcer with swollen, congested edge, or the contracted cicatrix can be seen. The symptoms of tracheal stenosis are dyspnea—the patient usually throwing the head forward—diminished laryngeal excursion, cough, and loud tracheal rhonchi. The stenosis is often visible in the larynoscopic mirror. The history of syphilis or the presence of other specific lesions greatly assists diagnosis.

Treatment.—In the stage of infiltration and ulceration the patient must be brought under the influence of the iodids as quickly as possible, and the diseased surface of the larynx may be treated by insufflation of iodoform or a mercurial lotion applied by spray or brush. Tracheotomy may be necessary either on account of the swelling of the soft parts or of the cicatricial contraction that follows the disease. Tracheotomy is to be performed in syphilitic stenosis of the trachea only when the symptoms are severe and when the surgeon is sure that he can open the tube below the stricture. Owing to the tendency of the disease to affect a wide extent of the tube and to attack particularly the lower part of the trachea, the operation cannot often be recommended.

Tubercular Disease of the Larynx.—Tubercle may occur primarily in the larynx, but is usually secondary to pulmonary tuberculosis, of which it forms a very grave complication. The disease occurs in the form of small scattered tubercles which caseate, soften, and then form superficial ulcers which extend and coalesce. They occur most often in the aryteno-epiglottidean folds, the interarytenoid fold, and the under surface of the epiglottis. The disease may extend to the ventricular bands and to the true vocal cords. There is usually considerable edema around the ulcers, and this may extend to the cartilages, causing perichondritis and necrosis of cartilage. If the ulcers heal, contraction of the upper orifice of the larynx may be produced.

The disease is more common in men than in women, and occurs especially between the ages of twenty and forty.

The **symptoms** of this affection are local pain, cough, dyspnea, and dysphagia, and a purulent expectoration in which tubercle bacilli are to be found. If stenosis occurs, it causes considerable increase of the dyspnea. In the earliest stages a laryngoscopic examination may show only swelling and anemia of the aryepiglottic folds; later, scattered nodules are to be seen, and later still superficial ulcers, with yellow base covered by a purulent secretion.

Treatment.—In addition to the general treatment of tubercle by diet, climate, fresh air, tuberculin, tonics, etc., the special measures adopted for laryngeal tubercle are: 1. To secure rest to the part by forbidding talking, and allaying cough by sucking ice, by a cocain spray, and sometimes by a morphin linctus. Tracheotomy has been suggested as a means of securing more perfect laryngeal rest; but the results of early tracheotomy have not been good, and the operation should not be resorted to for this purpose. 2. The local application of caustics and germicides. Lactic acid and carbolic acid are the drugs chiefly used. The two drugs can be combined by painting on a solution of carbolic and lactic acids in glycerin. The larynx must first be rendered insensitive by cocain (10 per cent.), and the strength of the solution is gradually increased as the larynx is found to tolerate it. At first the solution should contain about gr. xx of carbolic acid and ʒj of lactic acid in an ounce of neutral glycerin, and the strength of the solution may be gradually made even four times as strong. Injections into the diseased tissue and curetting the larynx before the application of the caustic have not proved beneficial. In a few cases

tracheotomy is necessary to relieve the urgent dyspnea due either to great swelling in the larynx or to stenosis.

Lupus of the Larynx.—This is a very chronic form of tubercular disease of the larynx which must be distinguished from the commoner and more rapid laryngeal phthisis. It attacks young people, women more often than men, and is usually associated with lupus of the skin. The favorite seat of the disease is the epiglottis, and it occurs in the form of a slowly progressing nodular infiltration with very tardy ulceration; when cicatrization occurs it may cause laryngeal stenosis. The *symptoms* are slight unless there is dyspnea from stenosis, being limited to slight cough and alteration of the voice. *Treatment* is not very successful. The ordinary general treatment for lupus elsewhere, and injection of tuberculin should be thoroughly carried out; locally, lactic acid or other caustic must be carefully and repeatedly applied.

New Growths in the Larynx and Trachea.—Tumors in the larynx, as elsewhere, are divided into the two great groups of the *innocent* and the *malignant*. Very little is known of their etiology. Papilloma is sometimes congenital. Chronic congestion of the larynx and over-use of the voice have been thought to lead in some cases to tumor-formation. Men are attacked more often than women, and while benign growths are met with in children and adults under fifty years of age, malignant growths are generally observed in those over fifty years of age. It has been thought by some that endolaryngeal operations upon benign growths may cause them to "degenerate" into malignant growths, but a careful collection of statistics shows that this is not the case. When a tumor originates within the larynx or trachea, it is called "intrinsic;" but when it invades either of those parts from neighboring structures, it is called "extrinsic." This distinction is of great practical importance.

Benign Tumors.—**Papilloma.**—Multiple sessile papillomata with a marked tendency to recurrence after removal are met with in children and adolescents. Single papillomata, sometimes pedunculated and with less tendency to recur, are at times seen in adults. They grow on the true and false vocal cords, the epiglottis, and the arytenoepiglottidean folds, and they may spread down into the subglottic larynx. A papilloma may grow in the trachea. These growths may be quiescent for a long period and then suddenly cause severe symptoms—dyspnea and aphonia—owing to sudden congestion, or to the impaction of a pedunculated mass in the glottis. Their growth is much more rapid in children than in adults.

Fibroma occurs in adults only, as a single smooth growth covered by pale-pink mucous membrane, and springing from one vocal cord; growth is slow, and there is no tendency to recurrence after removal.

Cysts.—Small, tense, globular retention-cysts are occasionally developed either in connection with the epiglottis or the true or false cords. They are met with in adults, grow slowly, and usually do not refill when once emptied.

Myxoma, adenoma, lipoma, angioma, and **chondroma** have been met with in the larynx, but are very rare. In the trachea polypi and cartilaginous and osseous tumors are among pathologic curiosities.

The *symptoms* vary with the size and position of the tumor. Alteration of the voice is the most frequent effect; the tone is altered, it tires easily, and hoarseness may pass into absolute aphonia. In the case of pedunculated growths sudden alterations of the voice may occur. A dry, hacking cough is sometimes met with, but is not a very frequent effect. Dyspnea is experienced when the growth is large; it is often paroxysmal. Usually inspiration is more difficult than expiration, but in subglottic growth expiration is the more obstructed. Tumors of the epiglottis cause dysphagia. Pain, as a rule, is absent, or at the most there is only an uneasy sensation in the throat.

With the laryngoscope the growth can be seen and its position, size, and other features noted. The irregular, cauliflower-like surface of the papilloma without ulceration is very characteristic when seen; but as this growth is met with in infants and young children in whom laryngoscopy is impossible or very difficult, the diagnosis has often to be made by symptoms alone or only after opening the larynx.

Treatment.—In adults benign growths can generally be removed by endolaryngeal operation. Cysts are to be punctured. A fibroma or a papilloma is to be removed with a special forceps or snare. These operations may have to be repeated. An extensive growth or a subglottic growth is best dealt with by thyrotomy. Growths in the trachea can only be dealt with through a tracheal incision.

Malignant Growths.—Squamous epithelioma is the most common form of malignant disease of the larynx. When originating in the larynx its progress is slow, and it is long before it invades the cartilages or infects the lymphatic glands. Epithelioma of the tongue and pharynx which spreads to the larynx (extrinsic epithelioma of the larynx) is a much more malignant disease. The intrinsic disease may arise in any part of the larynx, but most often originates in the ventricular bands or vocal cords. In its earliest stage it may be impossible to distinguish it from a benign growth, either a papilloma or a fibroma, but the infiltrating character of the disease is shown by the immobility of the cord, which is quite out of proportion to the size of the growth; later on ulceration occurs. As the ulceration progresses, cartilage may be exposed and separated, and the extensive destruction of the parts may to some extent relieve the dyspnea caused by the growth.

Symptoms.—The earliest symptom is hoarseness, which passes on into aphonia. Hoarseness out of proportion to the obvious changes in the larynx is in itself a very suspicious symptom, as it points to the infiltration of the cord and its consequent loss of free mobility. With the increase of the growth dyspnea occurs and may become intense. With ulceration of the growth there is liable to be hemorrhage from time to time, and the breath becomes foul.

The pain of cancer of the larynx varies. It is often an early symptom, and radiates from the larynx to the ear. In the late stage of the disease there is dysphagia, especially when the epiglottis is affected.

The *diagnosis* is often beset with great difficulty in the early stage, when alone treatment is of much avail. The age of the patient, early immobility of the affected cord, great hoarseness, and steady progress of the disease—unaffected by complete rest of the voice and antisyphilitic remedies—are the main facts on which the diagnosis must rest.

A portion of the growth may be removed and examined microscopically; if it shows the epithelium spreading down into the subepithelial tissue, the malignant nature of the disease is established.

In the late stage of the disease it can only be mistaken for syphilitic laryngitis; the duration of the affection, the history of the patient, and the influence of antisyphilitic remedies will clear up the diagnosis if the laryngoscopic appearances are not quite characteristic.

Cancer of the larynx ends fatally, generally by setting up septic bronchopneumonia from the inhalation of infective discharges from the ulcerated surface. The exhaustion due to the pain, hemorrhage, and inability to take food predisposes the patient to the occurrence of this pneumonia.

Epithelioma of the trachea occurs only from the disease in the esophagus spreading forward into the windpipe. Sarcoma of the larynx is met with, but less often than carcinoma.

Treatment.—An endolaryngeal operation may succeed in removing the entire growth in very early stages of the disease and when it is in a specially favorable situation. As a rule, this mode of attacking the disease is to be deprecated, for the difficulty of ensuring complete eradication of the disease is great, and if only partial removal is effected, the operation may stimulate the disease into more active growth. When the disease is entirely confined to the larynx, it may be removed by thyrotomy or by partial or complete laryngectomy. When too far advanced for either of these operations, tracheotomy may become necessary for the relief of the urgent dyspnea. Relief of pain must be secured by the use of cocain, phenacetin, or morphin.

OPERATIONS UPON THE LARYNX AND TRACHEA.

Endolaryngeal operations will not be described here, but only those external operations which general surgeons usually undertake.

Laryngotomy is a very simple operation by which an opening is made through the cricothyroid space. The patient's head should be thrown back and held straight. Feeling for the cricoid cartilage, the surgeon makes an incision 1 inch long exactly in the middle line of the neck, ending below over this cartilage, and with one cut severs the skin, platysma, and cervical fascia. A blunt hook is introduced on each side, and the divided tissues and also the sternohyoid muscles are drawn apart; the cricothyroid membrane is thus exposed, and is divided transversely for $\frac{1}{2}$ inch, and the tube introduced. In the first incision the anterior jugular vein may be wounded, if the cut is not exactly median; in the second incision the small cricothyroid artery may be cut, but this never causes troublesome bleeding. In cases of great urgency the larynx may be entered with one plunge of the knife thrust in close above the cricoid cartilage. The ease, rapidity, and safety with which this operation can be done single-handed are among its chief recommendations. I know a physician who saved a life by opening the larynx with his penknife and then holding the aperture agape by putting in the handle of a tooth-brush on the flat and turning it on its edge. If the surgeon has plenty of time, it is better to make a transverse cut through the skin, as the resulting cicatrix is less conspicuous.

Laryngotomy should be performed only in adults (owing to the small size of the child's larynx), in cases where only a temporary opening is needed merely for respiration and not for endolaryngeal operations, and when the cause of obstruction is not likely to extend down to and beyond the fistula.

This operation is employed—

In œdema glottidis not due to erysipelas.

In cases of impaction of a foreign body in the pharynx or the upper part of the larynx, causing dangerous dyspnea.

For the administration of an anesthetic when the surgeon desires to prevent any blood passing into the lungs in operations upon the mouth, jaws, and pharynx, and for that purpose puts a sponge over the upper opening of the larynx.

In all cases of sudden urgent laryngeal obstruction when the surgeon has to act without assistants or special instruments.

If a tube is worn for any length of time after laryngotomy, it is very liable to cause necrosis of one or both of the cartilages between which it lies. Very occasionally laryngotomy is followed by loss of voice.

Tracheotomy is a much more difficult and dangerous operation than laryngotomy, and in cases of young fat children or those with greatly swelled necks, and in the absence of skilled assistants it may be a very difficult procedure, since the operator all the time is hampered by the need for haste.

The patient, lying on his back, has the head either thrown back over the end of the table or, better, raised on a small, firm pillow or sandbag, so as to extend the cervical spine to the full. The chief assistant stands at the head, and his first duty is to keep the head exactly in the middle line.

The surgeon, at the patient's right side, feels for the cricoid cartilage, and makes an incision $1\frac{1}{2}$ to 2 inches long exactly in the middle line and downward from this cartilage. With one firm cut the skin, platysma, and fascia are cleanly divided and the interval between the sternohyoid and sternothyroid muscles opened. These muscles may, if necessary, be separated by the handle of the scalpel. The assistant holds them apart with a double hook on each side. The upper part of the windpipe, with the isthmus of the thyroid gland crossing its second and third rings, is thus exposed. With a second firm incision the surgeon cuts across the isthmus in the middle line quite down to the trachea, and at once seizes each half in a heavy Spencer-Wells artery-for-
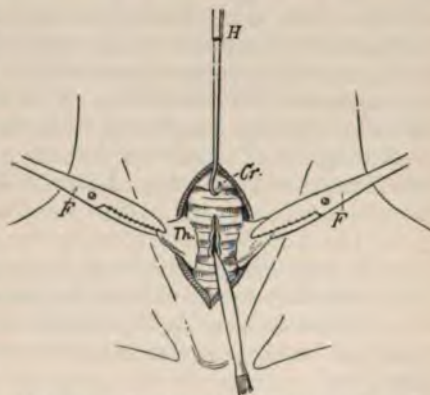

FIG. 82.—Tracheotomy. The trachea is exposed by the division of the isthmus of the thyroid body (*Th*), each side of which is held by a forceps (*F*). *Cr*, the cricoid cartilage, is fixed and drawn upward by a hook (*H*).

ceps, which, by dropping over the neck, raise the trachea into the wound. The hemorrhage from this incision is slight, and is at once arrested by the forceps. The trachea is then clearly seen and felt. A small, sharp

hook is thrust into the lower edge of the cricoid cartilage exactly in the middle line, and while the surgeon holds this up in his left hand he cuts up through three rings of the trachea exactly in the middle line. A closed tracheal dilator is introduced into this incision and then carefully opened. Coughing is usually excited by this procedure, and mucus, false membrane, blood, or a foreign body may be expelled. If the breathing has been greatly impeded, after a few deep full inspirations there is often a long pause followed by quiet easy breathing. Venous oozing stops as soon as the cyanosis is relieved; any artery that spurts should be pinched in a forceps as soon as divided. The tracheotomy tube should never be introduced in a hurry; the surgeon should wait until the dyspnea has been entirely relieved, until all hemorrhage has ceased, until the escape or removal of any blood, mucus, or diphtheritic false membrane, or the ejection of any foreign body, and then the tube should be carefully selected and gently introduced between the blades of the dilator and the latter instrument withdrawn. There is often need for haste in opening the trachea; there is never need for haste in inserting the tube, and much harm may result from undue hurry at this stage. The tube is held in place by tapes tied round the neck—not too tightly. Before he leaves the case the surgeon should satisfy himself that air is passing quite freely through the tube.

This is, I believe, the simplest and the safest way of performing tracheotomy, and if the operator will adhere to this method strictly, he will not meet with serious difficulties. In cases of calcification or ossification of the trachea it may be necessary to use very strong scissors, or even bone-forceps, to open the trachea, instead of a knife. Where, for special reasons, it is necessary to open the trachea low down (low tracheotomy), difficulty may be caused both by the depth of the windpipe and the large size and number of the inferior thyroid veins running over it. The deep fascia enclosing these veins may be torn through with a director instead of cut with a knife. Large bleeding veins must be seized in forceps and tied; smaller ones close spontaneously as soon as respiration becomes free. This "low" operation is not only more difficult but more dangerous than the typical operation.

A long list of accidents that may happen, and rules for their avoidance, may be drawn up. I would limit myself to the following few rules:

1. The head must be fixed in the median position.

2. Let the incision be long enough and exactly in the middle line.

3. Cut through the thyroid isthmus exactly in the middle line, and do not separate it from the trachea.

4. See and feel the rings of the trachea before attempting to open it.

5. Fix the trachea by a sharp hook at the highest part exposed, and cut it from below up, taking care not to thrust in the knife too deep.

6. Never be in a hurry to introduce the tube.

7. Make sure that the tube is in the trachea and below the obstruction.

Of the many tracheotomy tubes, the one introduced by R. W. Parker is the best. Durham's lobster-tail tube with movable collar is

also very good. Whenever a tube has to be worn for a long time, Baker's rubber tube should be substituted for a metal one; it is more comfortable and not liable to cause ulceration by pressure. Great care must be taken not to use any faulty tube or a partly worn-out one, as serious accidents have happened from the tracheal part becoming detached from the shield and falling into the air-passages. When it is desired to plug the trachea around the tube to prevent fluid, blood, serum, or pus passing from the pharynx or larynx into the bronchi, Hahn's long tube with a collar of compressed sponge, or Trendelenburg's tube with an inflatable rubber collar, or an ordinary silver tube with a tampon of iodoform gauze around it, is used.

The **after-treatment** demands great care and attention. The patient should be kept in a warm room, with a light "respirator" of 2 or 3 layers of sterilized gauze over the tube. It is neither necessary nor desirable to keep him in a very hot damp atmosphere, as this has a depressing influence. The tube must be kept free from mucus; as it is coughed up, it should be caught by the nurse and prevented from passing back with the next inspiration. Mucus and false membrane may lodge in the tube and there become inspissated, and even form a complete plug which, if not removed, will effectually suffocate the patient. To prevent this the inner tube should be removed every few hours and thoroughly cleansed in solution of soda, and gently replaced. Whenever any difficulty of breathing occurs, the inner tube should be removed. It is an old plan to pass feathers into the tube in the hope of removing mucus, etc., but this is a futile procedure. The outer tube should be removed only by the surgeon, as it may have to be instantly replaced owing to sudden dyspnea, and its introduction may be difficult. When there is a troublesome, dry cough, with very little expectoration, a spray of sodium bicarbonate, gr. xx–$\text{$\mathbb{3}$}$j, given through the tube affords great relief. The patient must be fed with a spoon, and not allowed to drink out of a cup. Tracheotomy is followed by insensibility of the larynx, so that food often passes through the glottis. I have known a patient asphyxiated by a draught of milk which all passed into the bronchial tubes. Sopped bread and sponge cake can often be more safely swallowed than fluid. Care must be taken to give children sufficient food; the pain in swallowing due to the wound and the presence of a tube in it sometimes makes them refuse food, and rectal feeding may be necessary.

The removal of the tube should be effected as soon as possible; if delayed for any reason, it is apt to be attended with difficulty and danger. The difficulty may arise from one of several causes. In some cases it is "nervous," and the removal of the tube is followed by laryngeal spasm. This is to be overcome by patience, by gentle and assuring words, and by gradually accustoming the larynx to its work. A tube with a large fenestrum in its convexity should be introduced; this allows some air to pass through the larynx. Gradually the laryngeal respiration can be made more and more by plugging the outer opening of the tube with the finger or a cork for increasing periods at a time, until at length the tube can be withdrawn. The difficulty may be due to a growth of granulations in the trachea around the tube, which become congested and swollen when relieved

from the presence of the tube, and thus obstruct the trachea.   Or it may arise from healing of laryngeal ulcers, causing stenosis.   Tracheal granulations should be painted with nitrate of silver.   Laryngeal stenosis may be overcome by bougies passed from below up, or by thyrotomy and excision of webs and bands.

Tracheotomy is performed as a preliminary to thyrotomy and laryngectomy, in cases of grave laryngeal obstruction from any cause, in some cases of tracheal stenosis and of pressure upon the trachea by tumors, for the removal of tumors and foreign bodies from the trachea, and for the removal of foreign bodies from the larynx or bronchi.

Thyrotomy.—After a preliminary tracheotomy and the introduction of a Hahn's tube, the thyroid cartilage is exposed by a vertical median incision from the hyoid bone to the cricoid.   The thyroid cartilage is then cut through along the middle line, but if possible the upper border of the cartilage is left intact.   The two halves are then held asunder, and the interior of the larynx can be explored, a foreign body removed, or a growth excised.   In the case of papillomata care must be taken to remove them very completely—scissors curved on the flat are the best instrument for this—and then the base should be touched with chromic acid.   Malignant growths in their early stage, before any infection of the cartilage, may also be freely removed and the cartilage left behind ; webs and cicatricial bands can be excised. After arresting bleeding the two halves of the thyroid are united by two or three sutures and the external wound closed.   If the two halves of the thyroid are not adjusted with perfect precision, so that the cords are not exactly on the same level, permanent hoarseness results, and it is for this reason that, whenever possible, the upper part of the cartilage should not be cut through.

Laryngectomy, or excision of the larynx, is a grave operation that is performed in a few cases of cancer of the larynx.   It is to be employed only in cases of " intrinsic " disease which are limited to the larynx and have not infected lymphatic glands or other parts, and which cannot be dealt with satisfactorily by the less severe operation of thyrotomy.   It should be performed only in patients who are otherwise in good health and with sound viscera.   If the disease is limited to one side of the larynx, only half the larynx should be removed (partial laryngectomy), for this is a less grave proceeding than total laryngectomy (Fig. 83).

The patient is prepared for operation by a preliminary tracheotomy a few days before.   The trachea is plugged by a Hahn's tube.   The larynx is exposed by a vertical median incision and a transverse incision at each end, and two quadrilateral flaps are reflected.   The larynx is opened, carefully explored, and then the half or the whole of the cartilaginous box is removed, as may be found necessary.   The wound is stuffed with iodoform gauze ; after suturing the skin, the patient is fed through a tube, and when healing is complete an artificial larynx is inserted.

Intubation of the Larynx.—This method of relieving stenosis of the larynx, which has proved of the greatest value in the stenosis of diphtheritic origin, had, in the days which immediately preceded the

adoption of the antitoxin treatment, established itself as the successful rival of the operation of tracheotomy. Over that operation it presented the following *advantages:* 1. It is more rapidly performed; 2. It involves no external wound with accompanying danger of infection, and the after-care is simpler; 3. The consent of the parents and friends to operation is more easily obtained; 4. The intubation tube does not have to be retained in position as long as the tracheotomy tube. Its *disadvantages* are: 1. The difficulty of administering nourishment while

FIG. 83.—Monks's case of unilateral laryngectomy for carcinoma. Condition three years after operation.

the tube is worn; 2. The fact that, if the tube is coughed up, the nurse cannot replace it, and the surgeon must therefore be summoned.

Since the advent of the antitoxin treatment it has been found that a much smaller number of cases of diphtheritic stenosis come to operation, and that the early casting off of the diphtheritic membrane under the influence of the antitoxin renders the retention of any tube necessary for a much shorter period. Under these circumstances the simpler procedure of intubation is, of course, to be preferred to tracheotomy, and has largely superseded it, even in hospitals, where, before the antitoxin treatment was adopted, tracheotomy was the routine procedure.

In severe cases, especially in adults, where the membrane has extended far down into the trachea or even the bronchi, with coinci-

dent septic infection, tracheotomy may even now be required, but in the majority of cases intubation is the operation of choice.

The Instruments.—The instruments, which have been but slightly modified from those first devised by O'Dwyer of New York, who first made the procedure practicable, consist of (1) the tubes; (2) the obturator; (3) the introducer; (4) the extractor; and (5) the gag.

The tubes are of brass, gold-plated, and are of the shapes shown in the illustration (Fig. 84).

FIG. 84.—Intubation: showing the scale, the gag, the introducer, the extractor, a tube, the obturator, and the introducer with a tube attached.

The expanded head rests upon the ventricular bands, and the prominent posterior end rests between the arytenoid cartilages. The slight anteroposterior curve of the tube carries the head backward, so as to avoid pressure upon the epiglottis. The fusiform enlargement of the center serves to retain the tube in the larynx.

Five sizes of tubes are usually supplied with the set: the smallest for children of one year and under, the next for those between one and two years, the next between two and four, the next from four to seven, and the largest from eight to twelve years. A metal scale supplied with the set enables the choice of the tube to be made at once.

The obturator is a steel plug, so arranged as to fit the tube at the upper and lower ends, and having a joint in the middle to facilitate the removal when the tube is in place. The upper end has a small hole upon which a thread is cut, so that the introducer can be secured tightly to it, and the rounded lower end projects slightly beyond the end of the tube, so as to form a probe-pointed extremity.

The introducer consists of a shank, bent at the end to a right angle and mounted on a handle. On the end a thread is cut, so that it can be screwed to the obturator, and over the shank fits a sliding tube, fitted with a button which when pressed forward causes two teeth at the anterior end of the sliding tube to project downward and throw the tube off the obturator.

The extractor is a curved instrument with two blades at the distant end, which are caused to separate by pressure on a spring. The extremity is introduced into the upper end of the tube with the blades closed, and then by pressure on the spring the blades are made to separate and engage the tube, which may now be removed.

Intubation tubes have been provided with a small wire loop at the top, so that extraction may be performed by introducing beneath the loop a blunt hook which is attached to the forefinger of the operator. The instruments described, however, are those most generally in use.

The Operation of Intubation.—The operation is performed as follows:

A tube is selected in accordance with the age of the patient, the selection being also guided by the size, which often does not exactly correspond to the age, and the fact that the male larynx is somewhat larger than the female.

The tube should be threaded with a loop of strong silk thread about 18 inches long, the obturator screwed to the introducer, and the tube fitted to the obturator.

The nurse sits upright in a straight-backed chair, and holds the

Fig. 85.—Intubation: correct position of operator, child, instruments, and assistants; the left hand of one assistant holds the child's head and the gag in the same grasp (Northrup).

child well wrapped up in a blanket to confine its arms and legs upright, with its back against her left chest and the head on her left shoulder (Fig. 85).

An assistant stands behind the nurse and holds the head upright

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and facing exactly forward. The operator, sitting directly in front of the patient, introduces the gag, placing it well back between the teeth at the left corner of the mouth, where it is kept in place by the assistant who holds the child's head. The operator then takes the introducer in his right hand and loops the ends of the thread over his little finger. He rapidly passes the index finger over the back of the tongue, feels and lifts up the epiglottis, and defines the aperture of the larynx. The handle of the introducer being held close to the patient's chest, the tube is passed into the mouth and along the index finger. As it approaches the epiglottis the handle of the introducer is rapidly elevated, so as to bring the tube into a vertical position, and the end of the tube slid along the end of the finger into the glottis by depressing the instrument, which is held rigidly in such a position that the tube is in the vertical position and the median line. When the head of the tube impinges on the ventricular bands, it is arrested, and while the index finger holds it in position the tube is set free by pressing forward the spring on the obturator, and the latter withdrawn with the introducer. As soon as this is accomplished the left index finger is at once withdrawn.

A sharp metallic cough, with free expectoration and relief of cyanosis and stridor, at once signalizes the entry of the tube. As soon as this is assured the gag is removed, and after waiting a few moments the loop of thread is cut, and while the tube is held in place by the left index finger pressed against its rim, the thread is withdrawn.

Some operators prefer to intubate with the child lying on the back on a table, the operator standing at the right side. This method is, on the whole, a little more difficult, except for those of large experience in the operation.

Extraction of the Tube.—The patient is placed in the same position as for introduction, the gag inserted, and the left index finger passed over the epiglottis till the rim of the tube is felt. The extractor is quickly introduced along the finger until the point sinks into the opening of the tube, and then by pressing the spring in the handle the blades are separated so as to engage the opening firmly. The tube is then quickly lifted up with the extractor and removed. If it slips off the extractor during removal, the left forefinger catches it beneath the head and draws it out.

It is possible to withdraw a tube without the use of an extractor, by catching the head between the tips of the fore and middle fingers and pulling it out. This procedure is valuable in cases where great haste is essential.

Owing to the weakness of the patients and the necessity of obstructing respiration for the shortest possible time, intubation must necessarily be performed as rapidly as possible; and in order to avoid injury to the delicate and important structures, no forcible efforts are justifiable. Swelling and infiltration of the parts often render their recognition by touch difficult and greatly complicate the operation. Owing to these considerations, a certain amount of skill should be attained by practice on the cadaver before the operation is attempted on the living subject.

If the first attempt is not successful, it should not be prolonged; but the finger and the instrument should be withdrawn, in order to

give the child a chance to breathe. Several rapid attempts are less dangerous than a single prolonged effort, with its attendant occlusion of the opening of the larynx.

If the tube has entered the esophagus instead of the larynx, as not infrequently happens, there will be no characteristic cough or relief of dyspnea, and the string will gradually shorten as the tube sinks downward. In that case the string serves for its removal.

In certain cases false membrane may be pushed downward by the tube and block its orifice, causing asphyxia. In this event, if the tube is not immediately coughed up, it must be at once extracted, when the membrane will usually be expelled by coughing. If relief does not follow, immediate tracheotomy is indicated.

It is therefore imperative to have the instruments for tracheotomy at hand whenever an intubation is performed for diphtheria, as there may be immediate and urgent necessity for them.

Extraction of the tube is often difficult, owing to the small size of the orifice into which the extractor must be introduced. The danger from putting the point of the extractor beside instead of into the tube, and injuring the larynx by separating the points too widely, may be obviated by setting the regulating screw so as to prevent it.

After-treatment.—If the tube is coughed up soon after intubation, and dyspnea returns, it is an indication that too small a tube has been used, and the next size larger must be introduced.

When a tube is coughed up after the second or third day, if dyspnea does not return, it need not be re-introduced. Before the days of antitoxin the tube could generally be removed in cases which progressed favorably by the sixth day. With the antitoxin treatment the time during which the tube needs to be retained has become much shorter.

The chief difficulty in the after-care of patients after intubation has been the difficulty of feeding. Adequate nourishment is naturally of the greatest importance, but has been difficult to secure on account of the milk and fluid nourishment getting into the tube, and so into the trachea.

Children can be made to take milk very well by sucking from a bottle or tube while lying on the back with the head hanging over the edge of the bed or the nurse's lap at an angle of 90 degrees, which prevents the milk gravitating into the trachea.

The most satisfactory method of feeding, however, and one which has been adopted as the routine at the Contagious Department of the Boston City Hospital, where enormous numbers of such cases are treated, is the introduction of the milk, warmed (and peptonized if necessary), through a soft-rubber catheter passed through the nostril and down into the stomach. There is no vomiting or danger of entrance of food into the trachea, large amounts of nourishment and stimulant may be easily and quickly introduced, and the children even become accustomed to the method and submit to it willingly. The milk is poured from a pitcher into a funnel which is attached to the catheter by a rubber tube.

By the antitoxin treatment the mortality of intubation in diphtheria has been greatly reduced, and the proportion of cases in which it is necessary to operate made much smaller.

TUMORS OF THE NECK.

Many of the tumors of the neck are described elsewhere: for Glandular Tumors see p. 99; for Congenital Tumors see p. 99 *et seq.;* see also Vol. I., p. 471; for Aneurysms see Vol. I., p. 905; for Bronchocele see p. 151.

Lipoma.—Three forms of fatty tumor may be met with in the neck: the common acquired circumscribed lipoma, the congenital lipoma, and the diffuse lipoma.

Acquired circumscribed lipoma may occur anywhere in the subcutaneous tissue of the neck, but its favorite seats are over the clavicle between the deltoid and pectoral muscles, and over the acromial part of the trapezius. The tumor is soft, lobulated, movable in the cellular tissue, ovoid or globular in shape, and it often projects more from the surface than other similar tumors because of the action of the platysma beneath it. If the tumor is causing any inconvenience or is known to be growing, it should be excised.

Congenital lipoma is a rare form of tumor. It lies beneath the cervical fascia, and is usually attached to bone, muscle, or nerve. In a case of this kind under my care the tumor involved the clavicular end of the sternomastoid muscle and its attachment to the bone. These tumors are soft, lobular, painless, stationary, or only slowly growing. The only *treatment* is excision. Owing to the depth and connections of the tumor, this is a more difficult operation than in the case of a superficial lipoma.

Diffuse Lipoma.—The neck is the favorite seat of hypertrophy of the subcutaneous fat. In its simplest form it causes the well-known and common "double-chin." In its extreme form it causes a very great and unsightly swelling all round the neck, immediately below the skull, and the head appears to lie in a kind of ruff of soft fat (Fig. 86). The disease is almost limited to the male sex, and attacks only the obese. Alcoholic excess seems to play some part in its etiology. It comes on in middle life, beginning below the chin and under the occiput, gradually increasing and spreading round the neck. The skin over this hypertrophied fat is reddened. The overgrowth of fat occurs chiefly beneath the platysma; it replaces the deep fascia, and often extends deeply in around the main blood-vessels and even quite back to the spine. There is no formation of independent masses of fat. The condition may be arrested and even improved by careful diet, combined with rigid abstinence from alcohol and thyroid feeding. If this treatment fails and the patient is very anxious to be rid of the disfigurement, the hypertrophied fat may be excised, provided the growth is not too extensive. The skin is reflected by suitable incisions and the mass of fat is separated on its deep surface, great care being taken not to wound large vessels, important nerves, muscles, or salivary glands. Deep processes of the growth should be cut across and left behind.

Sebaceous cysts may be met with in the skin of any part of the neck; they are most common in the middle line and over the sites of the branchial clefts. They in no way differ from similar cysts in other situations. (See Vol. I., p. 487.)

Dermoid cysts, and simple and multilocular serous cysts of the neck (hygroma) are described in Vol. I., p. 489.

Malignant Cystic Tumors.—In addition to the softened and fluctuating cancerous glands described on p. 126 there are certain other much rarer forms of malignant cystic tumors of the neck, the exact nature of which has not yet been definitely determined.

In some of these cases the cyst contains a large quantity of clear, straw-colored, richly albuminous fluid, which on standing deposits a flocculent precipitate of epithelial cells. The wall of the cyst is in part smooth, and from other parts masses of squamous epitheliomatous

FIG. 86.—Diffuse lipoma.

growth are sprouting. Such a tumor may be met with as a primary growth or as secondary to an epithelioma of the lip or tongue.

In other cases the fluid contents have been mucoid in character, distinctly ropy, and the wall of the cyst has been found to consist of spheroidal carcinoma. In these cases the inner surface of the cyst is either smooth or marked with bars and ridges like the columnæ carneæ of the heart. These tumors are always primary.

Both the primary forms of these tumors grow rapidly and destroy the patient within eighteen months or two years. They are usually mistaken for abscesses until they have been opened or tapped; at the autopsy no secondary growths have been found.

It has been suggested that some of these cysts are produced by an accumulation of lymph in an obstructed (epitheliomatous) gland. The

primary tumors are probably malignant affections of aberrant thyroids or of embryonic rudiments connected with the branchial clefts or the thyrolingual duct. Those with mucoid contents are most probably growths in outlying detached portions of the thyroid body.

These tumors infiltrate the tissues around them, and unless recognized early their removal is inadmissible.

SURGERY OF THE THYROID GLAND.

Congenital absence of the thyroid body is a very important and constant element in that form of congenital idiocy known as cretinism—a disease specially met with where goiter is very common. Thyroid feeding has been found to have a distinct effect in improving the physical and mental condition of cretins if commenced early in life.

Atrophy of the thyroid gland in later life and the complete removal of the gland by operation induce the grave changes which Gull first described and Ord called myxedema and Kocher cachexia strumipriva. The only *treatment* which has been at all useful in this condition is thyroid feeding. Cases of cretinism and myxedema do not come to surgeons for treatment, and any detailed account of these conditions would be out of place in a work on surgery, but they are of profound interest to the surgeon as indicating the supreme importance of the function of the gland and as enforcing the lesson that entire removal is an inadmissible procedure.

Thyroid Feeding.—Since the important influence of the thyroid gland on metabolism has been realized, many attempts have been made to influence the course of diseases by administering it to patients. There are two chief theories of the physiologic action of the thyroid. One is that the secretion neutralizes or destroys certain toxic principles in the blood. The other and more probable explanation is that the thyroid secretes some substance or substances which are necessary for the normal metabolism of the body, and the absence of these causes disease. The gland may be administered in the form of the fresh or cooked gland, but it is now generally given in the form of tabloids of the extract, each equal to 5 gr. of the gland. Care is necessary in the use of this drug. The dose at first should be one tabloid a day, given after a meal, and if no ill effects are produced, the dose may be gradually increased to 3 or even 5 tabloids a day. Many patients are unable to take more than 3 tabloids a day. The toxic symptoms are vertigo, giddiness, palpitation, faintness, nausea, tremors, and rapid action of the heart with a fall of arterial blood-pressure. Thyroid feeding is a specific in myxedema, and it has been used with great advantage in cretinism (when given early), lupus vulgaris, psoriasis, obesity, tetany, and hypertrophy of the thyroid gland. In some cases of idiocy resembling cretinism and in insanity it has sometimes appeared to do good. Removal of the ovaries followed by prolonged thyroid feeding has in a very few cases been followed by a temporary disappearance of cancerous growth in the breast and adjacent parts; and thyroid feeding alone, continued for many months, is credited with the cure of mammary cancer in at least one case. Many cases of cancer to which it has been given have not appeared to be influenced by it at all.

Thyroid colloid has recently been used, and is a more stable, active, constant, and pure form of the active principle of the thyroid gland. It is given in doses of $\frac{1}{2}$–1 gr.

Goiter.—The various enlargements of the thyroid gland are called bronchocele or goiter. Of these the following forms must be distinguished and separately considered:

1. Simple hypertrophy: Parenchymatous goiter.
2. Thyroid adenoma.
3. Cystic goiter.
4. Malignant goiter.
5. Exophthalmic goiter.

In very goitrous districts an epidemic form of the disease is occasionally seen, and there also it is not uncommon for the thyroid gland to swell to a marked degree during pregnancy and lactation, and subsequently recede.

If we restrict the use of the term hypertrophy to that form of disease in which increase of normal structure is associated with increased function, it would be more appropriate to apply it to the thyroid enlarge-

FIG. 87.—Goiter.

FIG. 88.—Case represented in Fig. 87, after operation, showing line of incision.

ment in Graves's disease or exophthalmic goiter in which there is reason to believe these conditions exist. In what is called simple goiter (parenchymatous goiter or simple hypertrophy of the thyroid) there is no evidence of any increased function of the gland. The names were given long before the thyroid gland was known to have any specific function (Figs. 87, 88).

Simple Goiter (*Parenchymatous Goiter, Hypertrophy of the Thyroid Gland*).—This is a very common form of goiter, and must be distinguished from that in which circumscribed tumors (adenoma) develop in the gland. It occurs in women more often than in men, and especially

in young anemic women. It is met with in all parts of the world, but is especially frequent in certain valleys in Switzerland, in Derbyshire, and in India. It may be met with in several members of the same family, and sometimes seems to be hereditary. The exact cause is unknown.

In this form of disease the whole gland is affected, although not necessarily to the same extent in every part. All parts of the gland— vesicles and stroma—are involved in the hypertrophy, and the tumor formed may reach a great size, projecting on each side of the neck and also in front of the trachea. The tumor is elastic, smooth, and rounded in outline, or with shallow fissures on the surface imperfectly dividing it into lobes. The muscles and vessels of the neck are displaced by the swelling; the patient is conscious of a sense of fulness and weight in the neck, but owing to the softness and elasticity of the growth, severe pressure-effects, such as dyspnea, dysphagia, and laryngeal paralysis, are not produced. Slight dyspnea on exertion is not uncommon. Associated with this thyroid enlargement there is usually distinct anemia; but whether as cause, effect, or accidental coincidence is not certainly known. This condition of hypertrophy comes on insidiously, usually increases slowly, and having attained a certain size, often becomes arrested; then it may spontaneously recede, and again it may increase. An adenoma may develop in an already hypertrophied thyroid and add to the severity of the symptoms. I recently operated upon a case of hypertrophy of the isthmus and right lobe of the gland, with a large adenoma on the left lobe. In some cases its growth is rapid. Slight increase in size of the gland during menstruation or pregnancy, which disappears when these conditions end, is not to be confounded with this true hypertrophy. There is a form of hypertrophy in which the stroma of the gland is specially affected and becomes fibrous and firm (*fibrous bronchocele*). This is much less common than the softer form; the gland does not attain a large size, but owing to its hardness may cause dyspnea by pressing upon the trachea.

Treatment.—A course of potassium iodid or of thyroid colloid often leads to the gradual subsidence of the enlargement of the thyroid gland, and in all cases these remedies should be thoroughly tried before an operation is resorted to. Where anemia is a marked feature of the case, iron or arsenic, or both, may be advantageously combined with the iodid. In India great success has attended the local treatment of thyroid hypertrophy with a strong iodid-of-mercury ointment.

The ointment, of the strength of 80 grs. to the ounce, is well smeared on the goiter, and the patient then exposes the neck to the direct rays of the sun. This blisters the skin, and often only one application is needed to secure the absorption of even a very large goiter. In other climates this treatment has not proved so successful. The ointment is usually used weaker—20 or 30 grs. to the ounce—and when strong sunlight is unattainable, the heat of a fire has been used instead; but the results obtained are not so good as to compensate for the pain and blistering it causes.

Iodin may be used locally in the form of the ointment, tincture, or liniment. It may also be injected into the thyroid gland. For this purpose a hypodermic syringe should be used; the needle detached from the syringe should be thrust well into the swelling, and if

blood does not flow freely out, the barrel of the syringe filled with tincture of iodin is attached and 5 to 10 ℔ of the fluid slowly injected. This causes very little pain, and is followed by slight induration of the part and then by its shrinkage. The injection has to be repeated many times, a fresh spot being chosen each time, and care must be taken not to inject the iodin into a large vessel. For a large goiter this plan is tedious and often disappointing.

When medical treatment has proved ineffectual and the size of the tumor or its pressure-effects demand relief, the surgeon should excise either the isthmus of the thyroid or one of the lateral lobes. In no case must the whole gland be excised.

Excision of the isthmus is the simpler operation of the two. The gland is exposed by a sufficient incision through the skin, platysma, and fascia, and the muscles are separated in the middle line. Many surgeons make the incision vertically in the middle line; I much prefer a curved transverse incision with the convexity downward, because it leaves a much less conspicuous scar. The exposed isthmus is carefully separated from the trachea; to facilitate this it may be divided in the middle line and each half separately freed and cut off, any bleeding vessels being ligatured; or it may be freed without division, a double silk ligature passed beneath it and tied at each end of the isthmus, and the intervening part cut away. The first method is the simpler and the better one, and the surgeon need have no anxiety as to hemorrhage. It has been thought that the effect of this operation is increased if the small end of a Paquelin's cautery is thrust into each lateral lobe through the stump of the isthmus and in several directions. Excision of the isthmus is a simple operation and yields good results.

Excision of one half of the thyroid gland is a more serious procedure. The gland may be exposed by a vertical median incision, an oblique incision along the front of the sternomastoid muscle, or, best of all, by a curved transverse cut through the skin, platysma, and fascia. The sternohyoid and sternothyroid muscles are separated and the gland thoroughly exposed. It is generally recommended to expose and securely ligature first the superior thyroid vessels at the front of the upper end of the lobe to be removed, and then the inferior thyroid vessels at the back of the lower end of the lobe. I prefer to divide the isthmus in the middle line and to dissect the one half off the trachea; when this is accomplished, the half of the gland is at once easily lifted from the wound and freed, and the vessels at the two extremities can be readily seen and ligatured. Great care must be taken not to injure the recurrent laryngeal nerve, which may be even embedded in a sulcus in the gland, although usually it lies quite protected in the groove between the trachea and esophagus. By freeing the gland first at the isthmus the surgeon has a better control over it than if he frees it from the side toward the middle line. This operation is generally followed by a decrease in size in the lobe that is left; in any case the pressure is removed.

Adenoma of the Thyroid Gland (*Cystic Bronchocele*).—The commonest form of goiter is that due to the formation within the thyroid gland itself of one or more circumscribed tumors composed of tissue exactly like that of the normal gland. These tumors are called thyroid adenomata. When fluid collects in one or more of the acini of such an adenoma and the tumor becomes mainly cystic, it is called

a thyroid cyst, cystic adenoma, or cystic bronchocele. The
are always secondary, and result from the collection of fluid
existing solid adenoma. The proportion of fluid in differe
varies considerably. In some the tumor is mainly solid, wit
more cysts varying in size from a pea to a walnut in it; in ot
bulk of the tumor is a cyst, the soft adenomatous grow
displaced to one side; and in some cases the tumor appea
entirely cystic, and it is only with the microscope that evic
thyroid tissue can be found in the wall of the cyst. So lon;
treatment of a cyst of the thyroid differed from that of a so.
chocele, it was important to distinguish between the solid
mainly cystic form of the disease; but now that the treatmei
two conditions is the same—extirpation—there is neither patl
nor clinical reason for distinguishing between the two form
disease, and we shall therefore consider all thyroid adenomata

FIG. 89.—Adenoma of the thyroid body: A, external surface of tumor, showing le
B, section through the same; C, capsule of the tumor.

The solid tissue of the adenoma is usually softer than that
normal gland, but microscopically is identical with it, consisi
acini lined with cubical epithelium. The fluid in the cystic por
primarily colorless or faintly yellow, transparent and glairy; bi
hemorrhage into the cyst it may become red, brown, or gree

color. It often contains cholesterin in such abundance as to be visible to the naked eye. The capsule of the adenoma is usually a very thin fibrous membrane; in old tumors it may be calcified in places, and occasionally this calcification extends to the adenomatous tissue within it. The capsule is, as a rule, only slightly adherent to the thyroid-gland tissue around it, so that the separation between the two is readily made. When the tumor lies in contact with the capsule of the gland itself the two fibrous membranes may become blended together, or at any rate inseparable, and occasionally there are in the deeper parts firm adhesions between the tumor and the thyroid-gland tissue. The trachea may be displaced to one side by a single tumor, or it may be compressed between two or more growths; this compression is always lateral, narrowing the tube from side to side, and never antero-posteriorly. Adenomata may attain a very large size, and then they stretch and displace the thyroid gland proper; but however large the tumor the gland is not incorporated with it nor destroyed by it. There may be a single tumor, or several adenomata may be scattered through the gland.

Etiology.—Very little is definitely known as to the causation of these tumors. Very rarely they are present at birth. They are quite commonly met with in successive generations, or several members of the same family, so that inheritance may play some part. They are much more common in certain localities than in others, particularly in the narrow valleys of mountainous districts, notably in India, Switzerland, and in Derbyshire (England) the disease is commonly known as Derbyshire neck, because of its great frequency in that county. It is by no means limited to these special goiter districts. Attempts have been made to show some connection between the saline ingredients in the water of goitrous districts and the disease, but at present we can only say that the exact cause of the development of these tumors is unknown. The disease is more common in women than in men, and usually arises between the age of puberty and that of full development of the body—in the second and third decades of life.

Symptoms.—The tumor formed by a thyroid adenoma is always an asymmetrical enlargement of the thyroid gland, and by that sign alone may be distinguished from simple hypertrophy of the gland. It may involve the isthmus alone, or one lateral lobe only; but even when all parts are involved by the development of several adenomata, the surface is very irregular and the different parts are enlarged to a very unequal extent. The tumor may develop in outlying parts of the gland and accessory thyroids, and so be found behind the sternum, or projecting into the posterior triangle of the neck, or lying over the front of the larynx. The tumor is globular or ovoid in shape, smooth, elastic, and if cystic it may give the sense of fluctuation, but the softer solid adenomata are so soft and elastic that they often seem to fluctuate. The tumor is neither painful nor tender, but its manipulation may cause some discomfort from dyspnea. If lying over the carotid artery, pulsation may be transmitted to the swelling. Apart from its position and shape the sign by which a thyroid swelling can be distinguished from any other tumor in the neck is its mobility with the larynx and trachea; when the patient swallows, the tumor is seen and

a thyroid cyst, cystic adenoma, or cystic bronchocele. These cysts are always secondary, and result from the collection of fluid in a pre-existing solid adenoma. The proportion of fluid in different cases varies considerably. In some the tumor is mainly solid, with one or more cysts varying in size from a pea to a walnut in it; in others the bulk of the tumor is a cyst, the soft adenomatous growth being displaced to one side; and in some cases the tumor appears to be entirely cystic, and it is only with the microscope that evidence of thyroid tissue can be found in the wall of the cyst. So long as the treatment of a cyst of the thyroid differed from that of a solid bronchocele, it was important to distinguish between the solid and the mainly cystic form of the disease; but now that the treatment of the two conditions is the same—extirpation—there is neither pathological nor clinical reason for distinguishing between the two forms of one disease, and we shall therefore consider all thyroid adenomata together.
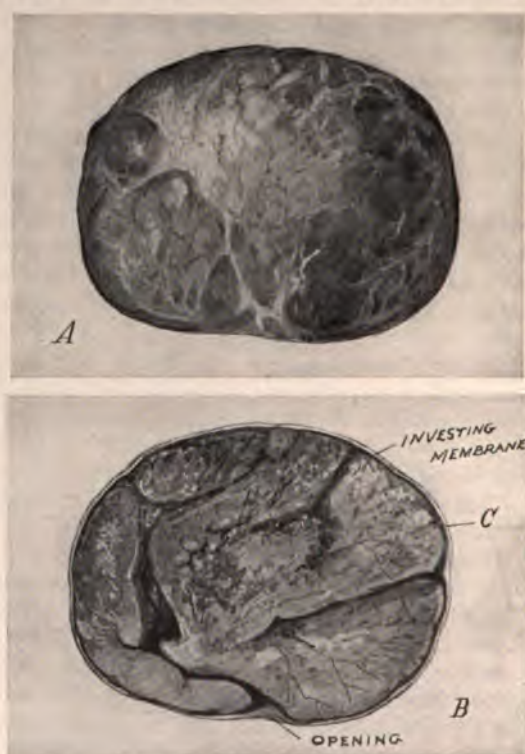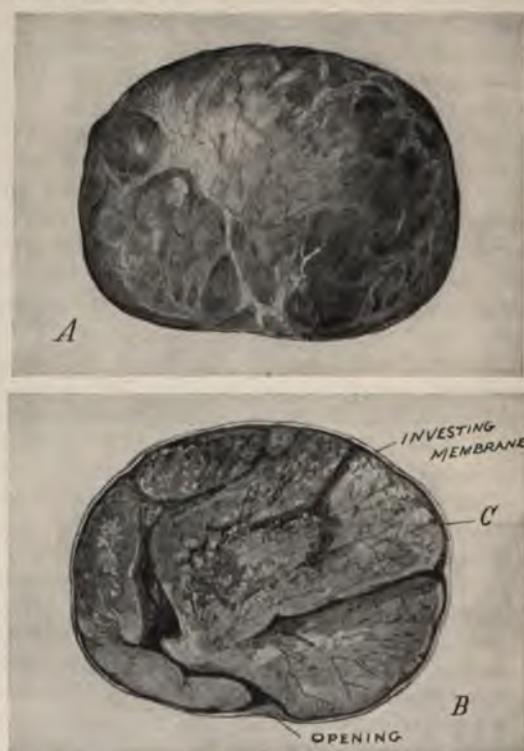
FIG. 89.—Adenoma of the thyroid body: *A*, external surface of tumor, showing lobulation; *B*, section through the same; *C*, capsule of the tumor.

The solid tissue of the adenoma is usually softer than that of the normal gland, but microscopically is identical with it, consisting of acini lined with cubical epithelium. The fluid in the cystic portions is primarily colorless or faintly yellow, transparent and glairy; but from hemorrhage into the cyst it may become red, brown, or greenish in

color. It often contains cholesterin in such abundance as to be visible to the naked eye. The capsule of the adenoma is usually a very thin fibrous membrane; in old tumors it may be calcified in places, and occasionally this calcification extends to the adenomatous tissue within it. The capsule is, as a rule, only slightly adherent to the thyroid-gland tissue around it, so that the separation between the two is readily made. When the tumor lies in contact with the capsule of the gland itself the two fibrous membranes may become blended together, or at any rate inseparable, and occasionally there are in the deeper parts firm adhesions between the tumor and the thyroid-gland tissue. The trachea may be displaced to one side by a single tumor, or it may be compressed between two or more growths; this compression is always lateral, narrowing the tube from side to side, and never antero-posteriorly. Adenomata may attain a very large size, and then they stretch and displace the thyroid gland proper; but however large the tumor the gland is not incorporated with it nor destroyed by it. There may be a single tumor, or several adenomata may be scattered through the gland.

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felt first to rise and then to fall. The respiratory symptoms vary; there may be none, or only a sense of pressure upon the trachea, or fulness in the neck; more often there is dyspnea on exertion, and occasionally stridor, with alteration in the voice. Dyspnea is most marked when the adenoma occupies the isthmus, or projects behind the trachea, or lies in the chest beneath the sternum. Dysphagia from pressure upon the gullet is less common, but is sometimes quite marked. The retrosternal bronchocele causes dulness behind the sternum, and loud tracheal breathing is heard over it. The subjects of adenoma are usually anemic, and the anemia is lessened by the removal of the tumor.

The tumor may grow very slowly, and, having attained a certain size, remain stationary for years; at other times more rapid growth is seen, and an acute enlargement of the tumor may occasionally occur, probably due to hemorrhage into it.

Treatment.—The only satisfactory treatment is the removal of the tumor. Internal or external medication, parenchymatous injection of iodin, the injection or drainage of cysts—all these measures are now superseded by the operation of excision. This operation should be performed when the tumor causes unsightly deformity, or occasions dyspnea, or dysphagia, or is known to be increasing. The special objects to be aimed at in operating are the removal of the tumor or tumors with the least possible injury to the thyroid gland, the arrest of hemorrhage, and the obtaining of an inconspicuous scar. Various incisions have been used, particularly a vertical median one, and an oblique one along the anterior border of the sternomastoid muscle. The best incision is a transverse one, curved with its convexity downward, carried through the skin, platysma, and superficial fascia, and avoiding injury to the anterior jugular veins. The flap thus marked out is raised, and a vertical incision is then made through the deep cervical fascia between the sternohyoids and the sternothyroids, and these muscles are separated from the thyroid gland and held well aside with retractors. An incision is then made over the most prominent part of the tumor, through the capsule of the gland and any gland-tissue beneath it until the outer surface of the adenoma is exposed. With a blunt dissector the adenoma is then carefully separated from the thyroid-gland tissue in which it is embedded, and every bleeding vessel is seized in pressure-forceps. It is usually quite easy to shell out the tumor, and if care is taken to keep close to its capsule the hemorrhage is not serious. The bleeding points are then ligatured, and the gland is examined for other adenomata, each of which is dealt with in the same way. All adenomata present in one lateral lobe of the gland can usually be reached through one incision in the capsule. If the adenoma is retrosternal, it is to be reached and enucleated in the same way. When all hemorrhage has been arrested the incision in the gland is closed by one or two fine sutures, and the depressors of the hyoid are held in place by sutures passed through the deep fascia; a third set of sutures unite the superficial fascia and the platysma, and finally a continuous suture accurately adjusts the edges of the skin. A light collodion dressing is all that is required over the wound. Repair is effected very rapidly, and in a week the patient is able to be up. The hemorrhage must be arrested very care-

fully before the wound is closed; even when this is done bleeding may occur shortly after the operation, excited possibly by vomiting, and the blood will accumulate beneath the deep fascia, compress the trachea, and cause death from asphyxia if the incision is not quickly torn open and issue given to the blood. The possibility of this accident makes it necessary to watch the patient closely for a few hours after the operation. In some cases a soft swelling of the neck around the thyroid gland is noticed the day after the operation, which gradually subsides and disappears. It is believed to be due to an escape of colloid material from the wounded surfaces of the thyroid gland. The rapid absorption of this secretion may give rise to serious symptoms of thyroidism. To prevent this the operator should be careful to inflict the minimum of injury upon the thyroid gland itself, and not to tear and bruise it.

The advantages of this method of operating are the preservation of the healthy thyroid gland, which has such an important influence upon nutrition, the avoidance of injury to parts around the thyroid gland, especially the great vessels and the recurrent laryngeal nerve, and the inconspicuousness of the scar. Keloid often occurs in scars in the neck, and is more frequent in vertical scars over the trachea than in the curved transverse scar; when this does not occur, the vertical scar is apt to stretch and remain as a broad band down the front of the neck. This does not happen in the curved transverse scar.

Malignant Goiter.—The thyroid gland may be the seat either of spheroidal-celled carcinoma or sarcoma, but the former is more frequent. Sarcoma is generally met with as a congenital growth; but with this exception, malignant disease attacks the gland in middle or late life, most of the cases occurring in patients between the ages of forty and sixty. In many cases a very chronic and apparently simple enlargement of the gland precedes the rapid growth of the obviously malignant tumor, and this fact renders it very difficult to estimate the total duration of the disease. It is usually said to be one of the most rapid of all malignant growths, but this is probably not entirely correct. I have under my care at the present time a lady who has had a malignant goiter for more than three years.

The growth commencing at one part usually quickly infiltrates the whole gland, forming a firm and uneven swelling over and on each side of the trachea. As it grows it spreads beyond the capsule of the gland, infiltrating the cellular tissue and the muscles of the neck, and becoming more uneven in outline and more fixed. Secondary deposits occur in the adjacent lymphatic glands, and these usually blend with the primary growth and make its outline more irregular. The recurrent laryngeal nerves becoming involved in the growth are paralyzed; the trachea and esophagus are compressed, and in this way dysphagia and dyspnea are caused. In some cases the malignant growth extends through the wall of the trachea and sprouts into that tube. This condition may be attended with hemoptysis, and if the growth ulcerates it may lead to bronchopneumonia and so bring on the inevitably fatal result. Death is caused by exhaustion, by asphyxia, or by bronchopneumonia.

Treatment.—The surgical treatment is very unsatisfactory. By the time the nature of the thyroid enlargement is evident the disease has

made such progress that complete removal of the whole gland is almost certain to be followed by speedy recurrence. Most surgeons therefore refuse to operate for this disease. If the diagnosis is arrived at in an early stage of the disease, before much of the gland or any of the lymphatic glands or more distant organs are affected, it might be justifiable to do a complete thyroidectomy and let the patient take thyroid tabloids regularly for the rest of his life. In the later stages, when dyspnea is urgent, but little benefit is afforded by tracheotomy, even when a long tube passing beyond the compressed part of the trachea is employed. If dysphagia is a prominent symptom, the food must be given in a liquid form.

Several cases have been recorded of pulsating vascular tumors of bones which have been found to have a structure practically identical with that of the thyroid gland—acini lined by a cubical epithelium and filled with colloid material. These rare tumors have been met with in the bones of the skull, the spine, the clavicle, and the long bones of the limbs, especially the femur. They always originate in the cancellous tissue of the bone, and they are invariably associated with an enlargement of the thyroid gland. This is regarded as the primary disease, and the growths in bone as secondary. The duration of these cases is much longer than is that of the more common form of malignant bronchocele, but, as a rule, the thyroid gland neither assumes such large proportions nor causes such marked symptoms.

Exophthalmic Goiter (*Graves' Disease*).—There is a form of enlargement of the thyroid gland in which the general symptoms are much more important than the local. It was first described by Dr. Graves, of Dublin, and therefore bears his name, and it is also called exophthalmic goiter on account of the exophthalmos which is one of the most frequent and striking symptoms of the disease. The group of symptoms thus named has been referred to disease of the central nervous system and also to changes in the cervical sympathetic, particularly the ganglia; but the following facts seem to show that the disease is dependent upon a change in the thyroid gland—1, there is a striking contrast between the symptoms of myxedema and those of Graves' disease; as one is known to be due to lack of the thyroid internal secretion, the other seems likely to be due to its excess; 2, the symptoms of Graves' disease in many ways resemble the effects of an overdose of thyroid gland; 3, the symptoms of Graves' disease are aggravated by thyroid feeding; 4, improvement has sometimes followed the removal of part or all of the thyroid gland in Graves' disease; 5, Graves' disease sometimes ends in myxedema—this is explained by the excess of thyroid-gland activity passing on into its defect; 6, epithelial proliferation has been found in the thyroid gland. The evidence is not complete, and there are several points still in obscurity; but such as it is, it seems to warrant the inclusion of Graves' disease among those of the thyroid gland.

Etiology.—The disease is much more common in women than in men. Predisposition to it is caused by the neurotic temperament and by debility occurring after exhausting conditions, such as pregnancy, chronic suppuration, anemia, and hemorrhage. The most frequent exciting causes are some sudden and excessive emotional disturbance —*e. g.*, fright, grief.

Symptoms.—The thyroid gland is uniformly enlarged to a varying extent; occasionally it forms a large tumor, and distinct adenomata may develop within it. As a rule, the enlargement is symmetrical and soft, and pulsation is felt in the tumor. This was formerly attributed to dilatation of the arteries in the gland, but it is now known not to be due to this cause, but to be a pulsation transmitted from the relaxed carotid arteries. The bronchocele may cause dyspnea and dysphagia from pressure on the trachea and esophagus. Some enlargement of the thyroid gland is probably invariable. The exophthalmus affects globes and is usually well marked; there is sometimes marked retraction of the upper lid, so that the sclerotic appears above the cornea (Stellwag's symptom) and the lids may be spasmodically contracted, and this causes very severe pain.

There is lack of the usual co-ordination between the eyeball and the upper lid, so that when the eye is turned down the upper lid follows in a jerky or incomplete manner (Graefe's symptom). With these there is overaction of the heart, with accentuation of the sounds. Frequent pulse, throbbing arteries, increased cardiac impulse, palpitation, exaggerated and frequent respiratory movements, anemia, a moist skin, irregular pyrexia, occasional attacks of diarrhea, polyuria, glycosuria and intermittent albuminuria have all been observed. The more marked nervous phenomena are fine rhythmical tremors, particularly in the tongue and upper limbs, mental excitement, and irritability which occasionally increases to actual mania.

These symptoms vary in intensity in different cases, and some may be absent altogether; they form a very characteristic group, and when severe the disease is very distressing.

Treatment.—Only the surgical treatment of this disease need be considered h e r e. Injections of perchlorid of iron into the thyroid gland are dangerous, of no certain value, and should not be practised. Excision of part of the cervical sympathetic has been performed, and benefit has been stated to have followed the operation; but this procedure cannot be

FIG. 90.—Graves' disease, for which thyroidectomy was performed, with partial relief of the symptoms (Warren).

recommended with any confidence. Partial or total thyroidectomy has been performed many times (Fig. 90). The operation is attended with

special risk both from hemorrhage from the large vessels in and around the thyroid gland and, it is believed, from the danger of a sudden absorption of a large amount of thyroid secretion. Of 68 cases of the operation collected by Oppenheimer, 9 died—5 almost immediately and 4 others within twenty-four hours. In only 18 of these cases was a cure obtained, but 26 others were said to have been benefited by the operation. The operation can only be recommended after a very careful consideration of all the aspects of any given case. It should be limited to the removal of one lobe of the gland only, and it seems to be wise to ligature the isthmus carefully before dividing it, and to take every precaution against hemorrhage and laceration of the thyroid tissue.

Should it be thought well to operate for relief of pressure upon the trachea, division of the isthmus will fulfil this indication.

Acute inflammation of the thyroid gland is a very rare condition, but it is occasionally seen occurring in the normal gland or attacking a thyroid cyst. It causes great swelling of the part, with superficial edema, which obscures the outline of the gland; this leads to great discomfort and a sense of suffocation. The temperature is high and the distress great. Suppuration speedily occurs.

The only **treatment** of avail is a free incision into the suppurating gland: this gives immediate relief.

SURGERY OF THE PAROTID GLAND.

The parotid gland fills an irregular cavity between the ramus of the lower jaw and the skull, and has intimate relations with several important structures. Above, it is limited by the zygoma; behind, by the mastoid process, external auditory meatus and sternomastoid muscle; below, it is separated from the submaxillary gland by the stylomaxillary band of the cervical fascia. Anteriorly the gland projects on to the face, lying on the masseter muscle. From the deep surface of the gland three processes may be traced, one filling the posterior part of the glenoid cavity, another lying beneath the neck of the mandible, and the third close to the styloid process and pharynx. The gland is bound down beneath the cervical fascia which is attached above to the zygoma. The external carotid artery and its two terminal branches, the temporal and internal maxillary, are in the gland, and the internal carotid artery with the internal jugular vein are immediately beneath it, while the posterior auricular artery lies between the gland and the digastric muscle. The temporal and internal maxillary veins unite within the gland to form the external jugular, and a large communication passes from this, also through the gland, to join the facial vein. The facial nerve passes through the gland from behind forward, and breaks up into several branches within its substance. The auriculotemporal nerve passes between the gland and the skull to join the temporal artery. The great auricular nerve is distributed to the skin over the gland. The duct passes from the front of the gland across the cheek and opens into the mouth at the top of a little elevation of the mucous membrane opposite the crown of the second molar tooth of the upper jaw. These anatomical facts are of great practical importance. They explain the great pain of acute inflammation of the gland, and the increase of this pain by opening the mouth; the occasional bursting of parotid abscesses into the auditory meatus, the pharynx, or the mouth, and the facial paralysis caused by disease in or operations upon the gland. They also impress upon the surgeon the necessity of great care in all operations upon the gland and the practical impossibility of complete removal of the gland, as for malignant disease.

Lymphatic glands are found lying on the gland and also sometimes embedded within it.

Parotid Salivary Fistula.—If a wound, accidental or surgical, opens Stenson's duct, it usually fails to heal entirely, and a salivary fistula results. An abscess of the parotid or in the cheek, allowed to burst or opened externally, may have the same sequel. When this occurs, clear watery fluid escapes on the cheek, and the great increase of the flow during mastication, the dryness of the mouth on the same side, and the amylolytic action of the fluid, all prove the nature of this

fluid—that it is saliva. The fistula is often quite minute; at other times it is large enough to admit a probe. It is a great annoyance to the patient, and the usual methods of wound-treatment entirely fail to cure it.

The best method of **treatment** is as follows: A straight surgical needle threaded with silver wire is passed into the fistula and made to perforate the cheek into the mouth. The needle is then unthreaded and threaded on the other end of the wire, and again passed through the fistula and into the mouth at a distance of about $\frac{1}{8}$ of an inch behind the first puncture. The two ends of the wire are then drawn tight and twisted together. The tissue enclosed in this loop of wire is strangled and sloughs, and the wound into the mouth, formed by the separation of this slough, is both free and without a tendency to close up. The saliva escapes into the mouth through this channel, and the fistula at once heals. I have found this method quite satisfactory, and far superior to any other.

Salivary Calculus (Fig. 81, *C*).—A calculus composed of phosphate of lime with some ammoniomagnesian phosphate may form in the parotid duct and gradually cause more or less complete obstruction of this narrow tube. When this occurs, the gland swells and becomes painful at each meal, the swelling slowly subsiding in the intervals, and there is a sense of discomfort at the seat of the calculus which can be felt in the cheek, moving a little in the line of Stenson's duct. As soon as this condition is recognized, the calculus should be cut down upon from the mucous surface of the cheek and removed. If allowed to remain, suppuration may occur in the gland, or ulceration starting in the duct may lead to abscess in the cheek and a salivary fistula.

The duct is occasionally blocked by a foreign body passing into it from the mouth. I once removed from the duct a grain of wheat which had set up a good deal of inflammation about the orifice in the mouth.

Simple Parotiditis (*Infectious Parotiditis ; Mumps*).—The parotid gland is the part most often affected in a contagious epidemic disease popularly known as mumps. The specific cause of this disease has not yet been identified, but it is assumed to be bacterial. The disease is most prevalent in spring and autumn, and attacks especially boys and girls from seven to fifteen years of age. A feeling of chilliness, with rise of temperature, malaise, headache, and loss of appetite, precede the local manifestation, and last for from twelve hours to three or even four days before any swelling of the gland is noticed. This swelling appears just below the ear and quickly spreads on to the face; it is firm, ill-defined, and tender. The skin over it is usually pale, but occasionally it is slightly flushed. There is local pain shooting up to the temple, increased by talking, mastication, or swallowing. Both glands may be affected from the first, but more often they are attacked in succession at an interval of a day or two. The febrile symptoms continue during the swelling of the glands, and after three to five days both the local and general symptoms subside. Suppuration is an extremely rare event. The disease may involve the submaxillary and sublingual glands and, it is said also, the tonsils. Occasionally it attacks other and more remote organs—the testicle in the male, the mamma, ovary, labium, and uterus in the female, and the cerebral men-

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inges in both sexes alike. It is stated that during an epidemic of mumps cases of orchitis and ovaritis occur without any affection of the parotid gland, which are caused by the same poison. This form of the disease is very serious; the acute inflammation of the secreting substance of the testicle often leads to atrophy of the organ.

The incubation period of mumps is usually twenty-one days, the extremes being fourteen and twenty-five days. The period of infection lasts from four days before to twenty-one days after the onset of the parotid swelling.

The **treatment** of mumps is medical rather than surgical. It consists of rest in bed, hot fomentations to the inflamed glands, a mild aperient at the onset of the fever, with salines afterward, fever diet, and subsequently tonics and change of air. In the very rare event of an abscess forming, it must be opened as soon as recognized, as in the case of parotid bubo.

Salivation by mercury or other sialogogues may excite inflammation of the parotid.

Parotid Bubo (*Suppurative Parotiditis*).—A diffuse inflammation of the parotid gland usually ending in suppuration may occur as a sequel of typhus and typhoid fever, scarlatina, measles, and also of any intraperitoneal operation and peritonitis. No explanation can at present be given of the association of this secondary suppuration with operations within the peritoneal cavity; it is not a part of a general septicemia or pyemia, for most often there is no secondary abscess. It usually occurs in one parotid only, but both glands may be affected. The abscess, if unopened, may burst externally, or it may open into the auditory meatus or the pharynx.

Symptoms.—The inflammation of the parotid causes an ill-defined swelling below and in front of the ear. The skin usually becomes reddened, and the edema of the subcutaneous tissues leads to pitting on pressure. The swelling is painful and tender on pressure. The temperature is raised. The swelling steadily increases and becomes boggy, and at length fluctuation can be detected. If the abscess is small and deep, it is very difficult and may be impossible to detect this sign, and the bursting of the abscess into the ear or the throat may be the first distinct indication of suppuration. The inflammation may subside without the occurrence of suppuration.

Treatment.—When the swelling first appears there is nothing to be done but to apply hot fomentations (to which belladonna or opium may be added) and to give a simple purge. As soon as there is evidence of suppuration—increased pain and tenderness, increased swelling, softening, pointing, or fluctuation of the swelling—the pus should be liberated. To open a parotid abscess an incision $\frac{1}{2}$ inch long should be made in a transverse direction and over the softened area. A director must then be forced through the inflamed gland, and when pus is seen to well up in the groove, a pair of dressing-forceps is gently thrust into the abscess, the blades opened and withdrawn. By using Hilton's method we are able to secure an external drain for the pus, and the patient will escape without the entire gland suppurating. A small drain-tube is placed in the abscess-cavity and a hot fomentation applied. The **prognosis** of this form of septic inflammation is good.

Tumors of the Parotid.—The tumors of the parotid gland are of two chief varieties—the *encapsuled* and the *infiltrating*. The encapsuled tumors are of slow growth, cause no secondary deposits, and often do not recur after removal. They cannot, however, be spoken of as benign growths, for if neglected they assume some of the usual characters of malignancy. This is accounted for by the presence of sarcomatous elements as well as of fibrous, mucous, glandular, and cartilaginous structures in them. They are sometimes classed as sarcomata, but it is better to speak of them as *mixed parotid tumors*. The infiltrating tumors are mostly, if not always, *spheroidal-cell carcinomata*.

Mixed Parotid Tumors.—These tumors usually make their appearance first below and in front of the lobule of the ear. They grow in the direction of least resistance, pushing aside the gland and the vessels and nerves within it, and project on the face. They are ovoid in shape, with a more or less lobed surface, and often have a deep process dipping down behind the ramus of the jaw, but they can be moved over the jaw and upon the skull. They are generally firm, but softer lobes or even fluctuating cysts may be met with. Their growth is slow, and in some cases, after attaining a certain size, they cease to enlarge; but if neglected they may attain a great size, grow

FIG. 91.—Parotid tumor.

down into the neck, and project into the pharynx, interfering with mastication and deglutition. As generally seen they are painless, do not interfere with the movements of the jaw, and do not cause facial palsy; the patient is merely troubled by the disfigurement of the conspicuous tumor. These tumors are met with in both sexes, and most often between the ages of seventeen and thirty-five.

Structure.—The mixed parotid tumor is an encapsuled growth. Within the fibrous capsule very varied structures are found, and in very different proportions in different cases. Thus, part of a given tumor will consist of fibrous tissue, and then part will be of spindle-cell sarcoma. In some cases a large part of the tumor consists of hyaline cartilage with typical cartilage-cells, scattered singly or in small groups without capsules through a clear hyaline matrix; and again areas of mucous tissue and of glandular tissue closely resembling the parotid itself are quite common. In some cases cysts are present, arising from dilated acini of a glandular part of the tumor.

The very varying structure of these tumors accounts for the different clinical course they pursue, and the presence of sarcomatous elements explains their occasional recurrence after removal, as well as their continuous enlargement and deep growth in the neck. This fact also makes it impossible to range these tumors under any one of the usual types of new-growths.

Treatment.—The only proper treatment is the excision of the tumor. This should be undertaken as soon as the nature of the swelling is recognized. The operation consists in the careful enucleation of the whole of the growth without injury to the gland in which it lies, or the many branches of nerve, or the vessels in the gland. It needs care in its performance.

The incision is generally best made in a vertical direction over the tumor, for in men the scar is then hidden by the whisker, and in women too it is less conspicuous than is a transverse scar. If the long axis of the tumor is transverse, it may be better to make the incision in this line, which has the advantage of being parallel with the facial nerve. The incision is carried carefully down to the capsule of the tumor, great care being taken not to divide any nerve. With a blunt dissector the capsule of the tumor is then separated from the gland, great care being taken to keep close to the tumor, to follow every outlying lobe of the growth, and also not to rupture the capsule and thereby possibly infect the wound with living tumor-elements. The tumor should be brought out entire, unruptured, and without any portion of the gland adhering to it. The operation is usually attended with trifling hemorrhage. Every bleeding vessel must be twisted or tied, and the wound carefully sutured and covered by a collodion dressing. If the tumor has been allowed to attain a great size, its removal is more difficult, and several large vessels may be met with and have to be divided. If care is not taken in this operation the facial nerve is divided, and more or less extensive and permanent facial palsy results.

As a rule, there is no recurrence of the tumor if removed completely and before it has attained a great size. The earlier these growths are removed the better the prognosis.

Carcinoma of the parotid is a disease of middle and old age. It begins as a small, firm nodule deep in the gland, gradually spreads through the gland, and then infiltrates the adjacent tissues—the coverings of the gland, the skin, the masseter and temporal muscles, the sternomastoid and deep structures of the neck and pharynx. In the form of the softer cellular spheroidal carcinoma it forms a rapidly growing tumor, while in the more fibrous scirrhous form of the disease

it is harder, less bulky, and also less rapid in its growth. From the first the tumor is fixed in the gland, and it quickly becomes immovable upon both the jaw and the skull, and interferes more and more with the movement of the jaw, until finally it prevents mastication entirely and greatly interferes with speech. The nerves in the gland are compressed and destroyed by the malignant growth, causing severe pain in the side of the ear and head, along the distribution of the auriculo-temporal nerve, and facial palsy. The skin over the tumor becomes infiltrated and then ulcerates, and profuse discharge and sometimes hemorrhage add to the patient's distress. In the meantime secondary deposits of cancer appear in the lymphatic glands in the neck, and sometimes in the lungs, other viscera, and the bones. Death is the inevitable termination of the case, brought about by the combined effects of pain, inability to take food, discharge, and blood-poisoning, or more directly by hemorrhage.

The *diagnosis* of this disease is arrived at by recognizing the infiltrating character of the growth, which speedily fixes it to the surrounding parts, its rapid growth, its tendency to ulceration, and the occurrence of secondary tumors.

Treatment.—Attempts have been made to deal with the disease by operation, but the results have not been such as to justify repetition of the procedure. Our present knowledge permits us to speak only of palliative treatment for this distressing disease.

Squamous epithelioma may extend into the parotid gland from a primary growth in the pinna or the skin of the part, or from a secondary growth in the parotid lymphatic gland.

SURGERY OF THE SUBMAXILLARY GLAND.

Wharton's duct is the most frequent seat of **salivary calculus** (Fig. 81, *C*). The calculi, which are composed of phosphate of lime with some ammoniomagnesium phosphate, are usually of an enlongated ovoid form, and vary in size from an oat to a date-stone. When small they lie loosely in the duct and may be pushed along it, and sometimes they project from the orifice of the duct. When larger they become impacted in the duct. This impaction is generally due in part to swelling of the wall of the duct excited by the irritation of the calculus. When this state of impaction is present, the submaxillary gland of the same side swells and becomes painful and tender at each meal, subsiding in the intervals between meals. There is swelling of the mucous membrane over the duct, and the calculus can be more or less distinctly felt. A purulent discharge may be seen exuding from the orifice of the duct. Occasionally suppuration occurs around the calculus.

The **treatment** consists in making an incision into the duct and removing the calculus. Unless the incision is made of sufficient length along and into the duct the extraction of the stone is difficult and painful.

The submaxillary glands are often involved in the direct extension of **epithelioma** of the mouth, or in extension from lymphatic glands infected by epithelioma of the tongue. The gland is occasionally the seat of mixed tumors similar to those met with in the parotid gland.

CHAPTER V.

SURGERY OF THE ESOPHAGUS.

Anatomical Considerations.—The esophagus is a hollow musculomembranous tube about 10 inches in length. It begins at the termination of the pharynx, at the level of the lower border of the cricoid cartilage, and opposite the body of the sixth cervical vertebra; it terminates in the stomach, opposite the body of the tenth dorsal vertebra. In its descent the esophagus describes two lateral and one anteroposterior curves. At its commencement it is situated in front of the middle line of the bodies of the vertebræ. It then deviates to the left, and at the root of the neck is about $\frac{1}{2}$ inch to the left of the median line. It gradually returns to the median line, which it reaches about opposite the body of the fifth dorsal vertebra, whence it descends in this line to the level of the ninth dorsal vertebra, below which it again deviates slightly to the left and passes through the diaphragm. The anteroposterior deflection is caused by the natural curvature of the spinal column, the upper part of the esophagus being carried forward by the anterior convexity of the cervical portion of the column, and then backward as it passes into the anterior concavity of the dorsal part of the column.

Caliber.—The esophagus is the narrowest portion of the alimentary canal; its average internal diameter being about $\frac{3}{4}$ inch. There are, however, three constricted portions—one opposite the cricoid cartilage, one at the point where it is crossed by the left bronchus, and one where it passes through the diaphragm. These constricted portions have an internal diameter of about $\frac{1}{2}$ inch; this was determined by Moulton, who with plaster of Paris obtained a cast of the esophagus *in situ*. By forcible dilatation the diameter at the constrictions can be increased to about $\frac{3}{4}$ inch, and in the rest of the canal to about $1\frac{1}{2}$ inches.

Attachments.—The esophagus is loosely attached to the surrounding structures by connective tissue, except where it passes through the diaphragm and at its termination in the stomach; hence but little trouble is experienced in passing bougies into the stomach, as the curvatures of the esophagus readily straighten out before the instrument.

Relations.—In the neck the esophagus is in relation, in front, with the trachea, the posterior surface of the left lobe of the thyroid gland, the left recurrent laryngeal nerve, branches of the left inferior thyroid vessels, and the carotid sheath; posteriorly, with the vertebral column, the left longus colli muscle, and the prevertebral fascia; on the left side, with the common carotid and subclavian arteries, the inferior thyroid vessels, and the thoracic duct; on the right, with the common carotid artery and the recurrent laryngeal nerve. In the chest it is in

relation, in front, with the trachea, the left common carotid and left sub-
clavian arteries, the transverse portion of the arch of the aorta, the left
bronchus, the posterior surface of the pericardium, and the left pneu-
mogastric nerve; behind, with the vertebral column, the longus colli
muscles, the thoracic duct, the third, fourth, and fifth right intercostal
arteries, the right pneumogastric nerve, the vena azygos minor, and,
near the diaphragm, the descending aorta; on the left side, with the
thoracic aorta and the pleura; on the right side, with the vena azygos
major and the pleura, the right pleura being more intimately associated
with it than the left.

Blood- and Nerve-supply.—The blood-supply to the esophagus is
derived from the esophageal branches of the inferior thyroid arteries,
thoracic aorta, and the intercostal, gastric, and left phrenic arteries.
The veins empty into the venæ azygos major and minor. The nerve-
supply is derived from the pneumogastric and the sympathetic. The
lymphatics empty into the posterior mediastinal glands.

Injuries of the Esophagus.—Injuries of the esophagus are
divided into two classes, internal and external. The former class is
much more common, because the esophagus is so surrounded by
important structures that injuries from without are generally so associ-
ated with injuries of other tissues that the esophageal wound is of
secondary importance. However, a few cases are recorded in which
the injury to the esophagus from external causes was unaccompanied
by severe injury to other structures. Injuries from within are, as a
rule, much less serious than those of external origin.

Injuries of internal origin may be divided into incised, lacerated,
and punctured wounds, burns, and scalds. The wounds are generally
caused by foreign bodies which have been swallowed accidentally,
although there are on record numerous cases in which professional
sword-swallowers have punctured the walls of the esophagus. Missiles
from fire-arms, the incautious use of extracting and exploring instru-
ments, and articles used in juggling, have also been responsible for
esophageal wounds. The most frequent source of internal wounds is
found in foreign bodies, such as spicula of bone, plates with teeth
intact, metallic bodies, pieces of china, etc.

In cases where the foreign bodies are not extracted, ulceration of
the esophageal wall follows, usually with rupture of the gullet into the
mediastinum, trachea or bronchi, the lungs, the pericardium, the pleura,
the aorta or other large blood-vessels; Andrews has reported one case
in which there was penetration of the heart.

Complications.—The complications which attend internal injuries
of the esophagus depend upon the extent of the wound and the struct-
ures which may be affected at that time or into which penetration may
occur as a consequence of ulceration. The pleural sac, the pericar-
dium, the bronchi, and other structures, are often wounded at the time
the injury is received. One case is recorded in which an insane person
forced the handle of an explosive toy into the gullet with such force
as to fracture the fourth rib at its vertebral articulation. Occasionally
a peri-esophageal abscess may form and burrow in the soft structures
of the neck, as the following case, which occurred in the author's prac-
tice, will illustrate. Mrs. B., aged sixty-six years, while in good health,

swallowed a small fish-bone. She complained of a sticking sensation in the right side of her throat, opposite the thyroid gland. Several days afterward, a red, tender, emphysematous swelling appeared on the right side of the neck. An incision was made over the most prominent point in the enlargement and a considerable amount of offensive pus liberated. The abscess-cavity extended behind the right lateral lobe of the thyroid gland and communicated with the esophagus, the outer wall of which had sloughed, allowing the escape of gas into the tissues. The fish-bone was not found. The wound was drained. A fistulous tract persisted, through which liquid food taken by the mouth escaped. The patient died of exhaustion.

Wounds of external origin are generally associated with injury to some of the surrounding structures. They have been caused by missiles from fire-arms, the horn of an ox, foils, swords, knives, daggers, used either intentionally, accidentally, or with suicidal intent. Frequently there is associated injury to the air-passages and large blood-vessels of the neck. The wound in the gullet may affect any portion of the wall, or, in rare instances, entirely sever the esophagus. The complications depend entirely upon the other structures involved; in most instances they are more important than the esophageal injury.

Burns and scalds may be caused by swallowing any very hot liquid or chemicals which have an escharotic action. Injuries of this class commonly occur as a result of swallowing corrosive chemicals with suicidal intent, although they may be caused by accidentally drinking hot liquids or taking chemicals by mistake. The following case is of especial interest, since it shows the extent of some of these injuries. The patient drank corrosive sublimate, mistaking it for whiskey; had burning sensation, with intense nausea and marked dysphagia. Eleven days later the mucous and submucous coats of the esophagus and stomach, with some muscular fibers of the former, were ejected. The esophageal portion of the cast was unbroken, but the gastric portion was somewhat torn. Hemorrhage was very severe for thirty-six hours, but then subsided. Cicatricial contraction took place, and in thirty-four days occlusion to within 4 inches of the stomach was complete. The patient died two months after the accident. (Reported by J. C. Brown.)

Symptoms.—The symptoms of esophageal injuries which are of internal origin are more or less severe and marked according to the amount of injury inflicted. In mere abrasions of the mucous surface, there will be slight pain during deglutition and the sensation of the presence of a foreign body. If the injury be more extensive, there will generally be some bleeding, which may cause a cough with expectoration of blood; or there will be vomiting of blood which has found its way into the stomach. When there is involvement of the surrounding structures, the symptoms will be markedly increased in severity. With involvement of a large blood-vessel, the symptoms will be those of internal hemorrhage; with involvement of the trachea or bronchi, there will be cough and expectoration of blood, food, and mucus; with involvement of the pleura or pericardium, there will be decided collapse. In all cases there is pain, distress, marked thirst, and dysphagia. Dyspnea will at times be prominent.

With injuries of external origin, there will be pain, nervousness, anxiety, distress, dyspnea, thirst, hiccough, with, at times, the escape of gas, mucus, blood, stomach-contents, etc., these symptoms varying greatly with the degree of involvement of the surrounding structures. At times, there are but few, if any, symptoms which will call attention to the esophagus, the diagnosis of esophageal injury in these cases being made post-mortem. In contusions which involve the gullet, there is usually tumefaction over the point of injury, with dysphagia and dyspnea, and later, signs of inflammation and abscess.

Diagnosis.—The diagnosis of internal injuries of the esophagus is generally made from the history of the case, the extent of the injury being surmised by the size of the foreign body, or the chemical or liquid causing it. Pain on deglutition, the sensation of an impacted foreign body, dysphagia, and regurgitation of blood, add to the certainty of the diagnosis.

In external injuries the diagnosis is generally self-evident, as there will be escape of stomach-contents, liquids which are swallowed, etc., through the wound. In some cases, however, the escape of food through the external wound may not imply involvement of the esophagus, as food may pass from the pharynx into the larynx and trachea and be voided through an opening in the latter structure.

Prognosis.—The prognosis depends upon the cause and extent of the injury. If the walls of the esophagus be but little injured, they will rapidly heal with the part at rest, and the only cause for an unfavorable prognosis will be the possibility of the formation of a stricture from the contraction of cicatricial tissue. When the injury is due to a foreign body which has remained impacted, the prognosis must be guarded. The ultimate outcome will depend upon the success or failure of the procedures taken to remove the body. When the esophagus has been injured by poisonous or escharotic liquids, the prognosis will depend largely upon the effect of the liquid on the general system. Locally there will generally be cicatrization with stricture, hence the prognosis must be guarded.

Treatment.—The treatment of internal injuries of the esophagus consists of rest of the gullet and muscles of the neck, in order that the mucous membrane may have an opportunity to recover. For this reason, rectal alimentation should be practised for a few days until the esophagus has sufficiently recovered to allow food to pass through it without increasing the deleterious effect of the injury. If irritating or caustic liquids have caused the injury, substances which will neutralize the poison and lessen its concentration should be administered. Large quantities of water should also be given, and immediately removed from the stomach either by the stomach-pump or by emesis.

In wounds of external origin the course of treatment will largely depend upon the extent of the injury to the esophagus and the complications which arise from involvement of the surrounding structures. If the wound in the esophagus be clean cut, it may be closed at once, if the general condition of the patient will allow. The wound in the superficial tissues may also be closed, if it be thought that the structures can be rendered aseptic; otherwise, a part of the superficial wound should be left open, to permit sufficient drainage if suppuration should

occur. Nothing but very small quantities of liquid food should be given by the mouth for at least a week, the strength of the patient being largely maintained by rectal alimentation. When the wound in the gullet is ragged, it cannot be closed.

Where there is a ragged wound of the esophagus, it is good surgery to create a fistula through which food may be administered. At all times careful attention must be given to the patient's general condition. If rectal alimentation will not suffice, small quantities of non-irritating liquid food may be administered by the mouth or through the fistulous tract. Extreme thirst may be allayed by rectal injections of warm water or warm salt solution, or small pieces of ice given by the mouth. When a fistulous tract persists, it may be subsequently closed by such surgical procedure as each case may suggest.

Rupture of the esophagus is a very rare occurrence. Ashhurst credits Mackenzie with having tabulated 13 cases, and Purslow with having reported 1 case. Fitz has collected all reported cases of so-called spontaneous ruptures of the esophagus, the first of which was reported by Borhaave in 1724; they were 9 in number, 7 of which he thinks were not spontaneous, but caused by some diseased condition of the esophagus. Zenker and von Ziemssen discredit the 2 cases claimed by Fitz as having been spontaneous, claiming that lesions present before the time of rupture were directly responsible for the same. Patek, while a resident at the German Hospital, Philadelphia, reported a case which he claims was of a truly spontaneous character. This, it seems, is the only case so far reported in which the spontaneous character of the rupture has not been questioned. The history of this case is as follows:

F. H., a German aged thirty-two years, was admitted to the German Hospital, Philadelphia, where he gave the following history : He had always enjoyed good health, never had any symptoms of dyspepsia, and had not taken any medicine for a long time. None of his associates had ever heard him complain of any sickness whatever. Shortly after having eaten of his second heavy meal of the day, he complained of a sudden sense of fulness in the epigastrium. Feeling nauseated, he endeavored to vomit, when he felt a sudden attack of pain, and exclaimed that something had broken. He immediately went into collapse with a feeble, running pulse, cold sweat, pallor, and intense agony. The pain was referred to the stomach and back. On admission to the hospital the patient was markedly cyanosed ; orthopnea was pronounced ; the pulse was almost imperceptible ; and the surface of the body was cold. The physical signs showed emphysema of the neck, dulness posteriorly due to an extensive effusion into the left pleural cavity, and a tympanitic note anteriorly on percussion over the upper lobe of the left lung. An autopsy was held four hours after death. · Much gas escaped when the left pleural cavity was opened. The left pleural cavity contained a large quantity of a grumous, brownish fluid, and particles of undigested food. On the left side of the cardiac extremity of the esophagus, just above the diaphragm, a longitudinal rent, about 1 inch in length, was discovered. The finger introduced into the opening entered the stomach, and pressure upon the stomach forced fluid matter into the pleural cavity through the rent. The esophagus, with the stomach attached, was removed. A thorough examination, macroscopic as well as microscopic, was made, which showed the following conditions : The mucous membrane of the esophagus was smooth and glistening, and in every respect perfectly normal ; the stomach was in the same condition ; the edges of the esophageal rent were clearly defined ; there was no sign of ulceration of the mucous membrane, with the exception of a very small round area a $\frac{1}{4}$ inch in diameter, which seemed to be devoid of epithelium, and was opposite the line of rupture. Ante-mortem and post-mortem maceration, from contact with the gastric contents, would be sufficient to explain this abnormality.

In all of the other cases of supposed spontaneous rupture of the esophagus there were signs of ulceration, stricture, pathologic growth,

esophagomalacia, etc., which must have weakened the resisting powers of the esophageal walls. Violent vomiting in such cases is apt to be followed by rupture of the organ, owing to the lessened resistance in conjunction with the *vis a tergo* exerted by the stomach in the endeavor to empty itself.

The **symptoms** of rupture of the esophagus are sudden marked pain in the epigastrium referred to the back, dyspnea, orthopnea, running, feeble pulse, suppression of urine, cyanosis, and interstitial emphysema.

FIG. 92.—Rupture of the esophagus.

The **prognosis** is always unfavorable, on account of the impossibility of effecting any treatment which would prove of value.

The **treatment** should aim to relieve the main symptoms as they arise, and thus make the patient as comfortable as possible.

Rupture of the esophagus from external causes may occur as a result of ulceration of the wall due to encroachment of mediastinal growths or aneurysms of the aorta. Patek has also reported the following case: The patient was admitted to the German Hospital with a severe cough. The pulse was good and equally strong on both sides. The pupils were equal, dyspnea was slight, and there was no dys-

phagia. A pulsating tumor which produced slight bulging, but no bruit, was detected upon the right side of the chest. The patient was found dead in bed a short time after he had been walking around the room. The post-mortem examination showed the abdomen to be distended, and dulness over the area of the stomach. An aneurysm of the ascending portion of the arch of the aorta was found. The descending portion of the arch of the aorta showed another aneurysm. The latter was filled with soft clots and opened into the esophagus. The dilated stomach was opened *in situ*, where a clot the exact mould of the stomach was found. The aneurysm of the descending portion of the arch had ulcerated into the esophagus and ruptured into it.

Foreign Bodies in the Esophagus.—Foreign bodies are of significance only when they become impacted more or less permanently. Foreign bodies lodged in the esophagus will temporarily cause annoyance while they remain *in situ;* but as they soon pass into the stomach or are ejected by emesis, they play a small rôle in esophageal affections. Permanently impacted bodies which require surgical interference are of more moment, and are so frequently seen that they form the largest class of surgical affections of the esophagus.

The different bodies which may become lodged in the esophagus include almost everything that can pass into the pharynx. J. Solis-Cohen has given the following revised list prepared by Poulet :

" *Animate.*—Leeches, fishes, salamanders, mice, eels, frogs, ascarides lumbricoides, tæniæ, hydatids.

" *Inanimate, Organic.*—Beef-bones, fish-bones, other food-bones, nasal bones, vegetable sequestra, pieces of meat and vegetables, fruits and kernels, potatoes, pieces of wood and grain, lung, hair, egg, cork, comb, sponges, spindle, dominoes, violin-pegs, comfits, cake, flute, stopper, teeth, dental plates, masses of rags, feathers, tobacco.

" *Inorganic.*—Pins, needles, pens, coins, flat and round bodies (child's saucer, medals), toys, dental plates, artificial teeth (metallic), palate obturator, knives, scissors, compass, razors, blades, sword-blades, forks, spoons, rings, buttons, buckles, keys, pebbles, glass vials, pieces of stone or brick, thermometers, bullets, bullets from projectiles, bars, pieces of pots, eyeglasses, butcher's hone, iron file, brass chains, lead seals, tubes and pipes, sounds, plaster, padlocks, fish-hooks, sucking-bottle, beads, diamonds, table-rollers, barbed wire, meat-skewers, tin tags from tobacco."

The main significance of the body impacted depends upon its size and shape. With large bodies there will be marked difficulty of swallowing, and hence it will be most difficult to nourish the patient. Irregular or sharp-pointed bodies are liable to puncture the walls of the esophagus and produce complications most difficult to treat.

Foreign bodies are more frequently found in the esophagus of the very young and of the insane. Other conditions predisposing to this affection are loss of teeth, paralysis of the muscles of the face, lips, tongue, pharynx, and esophagus, various inflammatory conditions of the postbuccal region, and strictures, growths, and malformations of the esophagus.

Foreign bodies usually lodge at one of three points: opposite the cricoid cartilage, where the left bronchus crosses the gullet, or at the point where the esophagus passes through the diaphragm. At these three places the caliber of the esophagus is smaller and less dilatable than is the rest of the canal.

The **symptoms** caused by foreign bodies vary greatly. There is generally a feeling that something is stuck in the gullet, and some slight nausea. In more severe cases there will be vomiting, marked

pain on deglutition, dyspnea, dysphagia, aphagia, and hemorrhage if there
be any laceration of the walls of the esophagus. These symptoms are not
at all constant. Calvert reports a case in which a tooth-plate had been
impacted in the esophagus for eight months, with scarcely any symp-
toms. Bowley reported a case for Marsh, in which a child of three
and one-half years retained an impacted coin in the esophagus, without
any symptoms except slight nausea. Lemaistre has cited a case in
which an infant of six months swallowed a leaden brooch. It lodged
just below the cricoid cartilage, where it was found and removed by a
lateral esophagotomy fourteen days after the accident had happened.
But few symptoms had presented themselves. The author removed
from the esophagus of an insane man, by left lateral esophagotomy, a
plate which contained five artificial teeth. The only indications of the
condition were the absence of the false teeth and inability to feed the
patient. The operation was performed fourteen days after the occur-
rence of the accident. In severe cases the symptoms may be most
intense and speedily terminate in death.

FIG. 93.—Foreign body (penny) in the esophagus.

Complications depend upon the size and character of the impacted
body. If it remain *in situ*, ulceration of the esophageal wall will follow,
with rupture of the wall and involvement of the pleura or mediastinal
spaces. The foreign body may puncture the wall and enter any of the
viscera in close proximity. Calvert reported a case where one flange
of a tooth-plate ulcerated into the thoracic aorta.

Silver cites a case in which death resulted from pericarditis. It was
found that part of a plate, with three or four teeth attached, was lodged
partly in the esophagus and partly in the pericardial cavity (Maylard).
Perforation may take place into the trachea, bronchi, the pleural cavi-

ties, or any of the large blood-vessels in close proximity. Ulceration may end in abscess-formation which may open externally, with resultant esophageal fistula. Induration of the structures surrounding the gullet may occur, with complications arising from involvement of, or encroachment upon, the adjacent organs.

Diagnosis.—With the present knowledge of the Rōntgen rays the diagnosis of certain foreign bodies in the esophagus is remarkably easy, if these rays can be applied. With the fluoroscope, one has little difficulty in locating the body and determining the size and shape of the same. When a picture of it can be obtained, there is no difficulty in
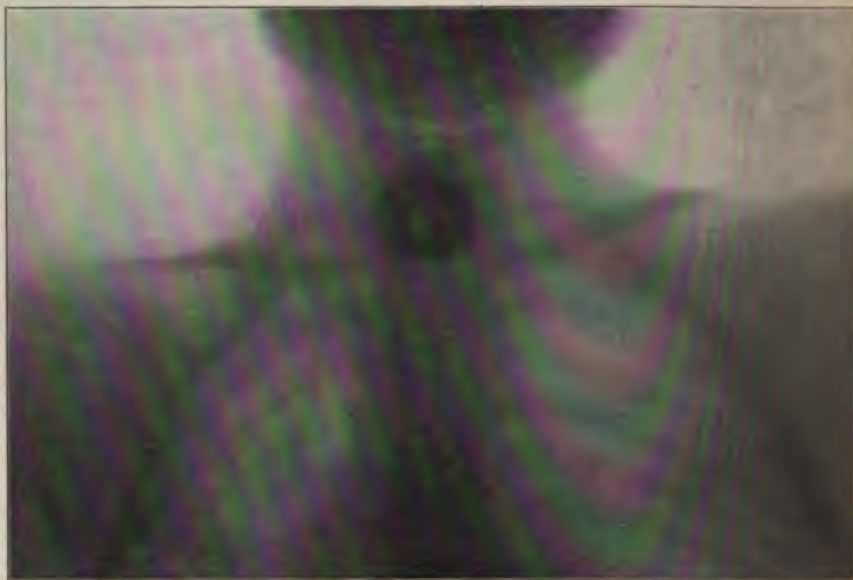
FIG. 94.—Foreign body (tin whistle) in the esophagus.

carefully studying the size, shape, and location of the body, and at once determining the plan of treatment. With bodies which allow the Rōntgen rays to pass through them the fluoroscope is, naturally, of no value in diagnosis. In these cases one must rely on the history of the case, and palpation through both the pharynx and the tissues of the neck. Large bodies may readily be recognized by lateral pressure on the sides of the neck. At other times they can be felt by introducing the finger into the pharynx. If a mass cannot be distinguished by manual palpation, resource must be had to the probang or bougie. With these instruments the body can often be located, and at times dislodged. If there be much mucus in the esophagus the instrument is liable to glide past the obstruction and enter the stomach, giving the impression that the body has passed downward. If such were the case, all of the more prominent symptoms would at once subside. If they persist after the bougie has passed into the stomach, the probability is that the foreign body still remains in the esophagus, but that it is covered either with mucus or even by a fold of mucous mem-

brane, as in a case quoted by J. Solis-Cohen. When the bougie is passed, it should be carefully graduated in order to find the exact location of the body. When these means fail, the diagnosis must be made entirely from the symptoms—difficulty of deglutition, nausea, emesis, etc.—most of which will increase in severity if the obstruction remain. Other cases will give but few symptoms, and there will be much doubt in regard to a correct diagnosis. Esophagoscopy may be tried. Von Hacker is said to have seen an impacted bone as low in the esophagus as the bifurcation of the trachea. Von Hacker used the panelectroscope. He has also reported diagnosis of foreign bodies by means of the electro-endoscope.

Prognosis.—The prognosis in cases of foreign bodies in the esophagus must always be guarded as long as the body remains impacted. If the object be large, the prognosis must be very unfavorable. In the latter instances death may follow rapidly through ulceration and rupture of the gullet into one of the adjacent viscera. This may be brought about by efforts at emesis, the *vis a tergo* being sufficient to force the body through the wall of the esophagus. The longer the body remains in the esophagus the graver must be the prognosis. Calvert's case of sudden death from ulceration of one flange of a tooth-plate into the thoracic aorta, gave very few symptoms for eight months after the plate had been swallowed. Maylard quotes a case of Lennox Browne, in which a tooth-plate had been impacted for three and one-half years. It was finally removed by means of a coin-catcher. Much depends upon the size and shape of the impacted body. Pins and sharp-pointed bodies have worked their way through the wall of the esophagus and have been removed from under the skin. Death may occur from inflammation of the esophagus, ulceration into one of the neighboring blood-vessels and consequent hemorrhage, eclampsia, caries of the vertebræ following esophagitis, ulceration into the pericardium and consequent pericarditis, and injury to the spinal cord due to ulceration of the intervertebral substance, or starvation when it is impossible to remove the impacted body.

The **treatment** of foreign bodies depends entirely upon the shape, size, and position of the body impacted. Every effort should be made to secure a correct diagnosis, and then guide the treatment accordingly. With the Rôntgen rays all metallic and bony substances can be readily located and their size and shape determined. Efforts should be made to dislodge the object so that it may pass into the stomach, or to remove it through the mouth. To accomplish the first the patient should swallow masses of partially masticated food, in the hope that they may dislodge the body and carry it downward.

To bring the body out through the mouth many means may be adopted. First through emesis. This is a dangerous practice if the bodies have sharp points and are large, as the points or rough edges are likely to puncture the wall of the esophagus and thus make the removal much more difficult, and also add to the danger of the condition by setting up esophagitis or some inflammation in the surrounding tissues. Emesis may be induced by administering emetics when the obstruction is but partial; by rectal injections, as tobacco, as pointed out by Poulet; by hypodermic medication, as the hydrochlo-

rate of apomorphin; or by mechanical titillation of the uvula and pharynx. The last is probably the best means of producing emesis, as it is quicker and causes more violent retching. It must always be remembered that endeavors to remove bodies by emesis should not be prolonged, and should at best be tried only in those cases where there is no danger of puncturing or rupturing the wall of the esophagus.

When practicable, the body should be removed through the mouth by means of one of the many instruments devised for that purpose. Among them may be mentioned Bond's, Burge's, Cloquet's, and Cusco's forceps, Mathieu's jointed forceps, Gama forceps, Petit's hook, Graefe's coin-catcher, and the ring coin-catcher. Either the bristle probang or the horsehair parasol snare may be likewise used.

When difficulty is experienced in removing foreign bodies with any of the above instruments the Röntgen rays should be used. In these cases the hand of the operator is guided by the assistant, who views the esophagus and the foreign body in the fluoroscope. In this manner the instrument can be readily made to do the work, if it be possible to remove the body.

When the above methods fail, operation is the only alternative. This procedure is accomplished either through the stomach, withdrawing the object downward into that organ, or by esophagotomy, the choice of operation depending upon the size, shape, and position of the body.

Malformations of the esophagus consist of congenital atresia, congenital stenosis, torsion, termination in a blind pouch, absence of the esophagus, intercommunication with the air-passages, and membranous obstruction, partial or complete (Fig. 95). The etiology of these malformations has never been accounted for. The **symptoms** of malformations show themselves as soon after birth as the child takes food. The child ejects the milk taken almost immediately. The food remains unchanged, and in quantity is about the same as when ingested. If there be communication with the air-passages, there will be marked dyspnea after feeding, and cyanosis and death if the food be not rejected at once. Meconium may be passed, although the child received no food into the stomach. If there be any doubt as to the condition of the gullet, an attempt should be made to pass a bougie. This, with the rapid emaciation and the immediate rejection of all the food taken, will make the diagnosis positive.

Prognosis.—The prognosis is always very unfavorable, the child

FIG. 95.—Congenital malformation of the esophagus. Communication with air-passages from below; sacculation above.

generally dying from inanition in a few days, the length of life depending upon the nutrition of the infant at birth.

The **treatment** is limited to such surgical procedures as may be advisable for the condition found. Gastrostomy is the only rational procedure allowable. If life can be sustained through the artificial mouth, surgical interference may later effect a cure for the condition of the esophagus, although the complication of a communication of the esophagus with the air-passages will render the operation less likely to meet with success.

Sacculations of the esophagus may originate from one of four causes: they may be congenital, and may follow stricture of the esophagus, pressure from within the esophagus, or traction from without. The congenital variety is due to some developmental change in the esophageal wall. In strictures of the esophagus the portion of the gullet immediately above the constriction often dilates from the accumulation at that point of food which is unable to pass into the stomach. Pressure from within the esophagus produces sacculations through the ordinary efforts at deglutition, when a weakened section of the wall of the esophagus is unable to withstand the ordinary pressure thus exerted. Traction from without is the result of some inflammatory trouble with consequent adhesions to the walls of the gullet, the contraction of the inflammatory exudate causing a tugging at the walls, with subsequent pouching. The most frequent site of sacculations is opposite the cricoid cartilage.

The **symptoms** of sacculation begin with a feeling of oppression and slight dysphagia. This feeling of oppression may begin at a high point and work downward, or *vice versâ*. Food will collect in the sac, with tumescence in the neck, if the sac be located in this region. Pressure on the tumor will empty the sac, giving immediate relief to the patient. Regurgitation will also afford relief. The food thus ejected will be of alkaline, of neutral reaction, and will be undigested, thus showing that it has not been subjected to the action of the gastric juice. The **diagnosis** is generally easy when the sacculation is in the neck. The tumescence, which disappears on pressure and returns only after eating, the absence of acidity of the ejected food, and a fetid condition of the breath if the food remain long enough in the sac to undergo fermentative changes, generally make the diagnosis clear. When the sac is in the thoracic portion of the gullet the introduction of bougies assists in the diagnosis. At times the bougie will become lodged in the sac, especially when it is full. After regurgitation or emptying of the sac the bougie may readily pass into the stomach. Repeated endeavors to pass the bougie will soon clear the diagnosis, the fact that it will at times pass freely into the stomach excluding the diagnosis of stricture.

The best **treatment** for sacculations is their complete excision. The first steps in the operation are performed as in the operation of esophagotomy. After the esophagus has been exposed and the sacculation located the latter should be freed from the surrounding structures and removed, either by excision or ligation at two places, and removal with the thermocautery. After excision of the sac the wound in the esophagus may be closed by suturing the mucous membrane alone, or

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by suturing together the entire thickness of the edges of the esoph-ageal wound. The external wound may be at once entirely closed, or partially closed, thus allowing drainage. For a few days nutrition should be furnished by rectal alimentation.

Tumors of the esophagus are of two varieties, benign and malignant. **Benign tumors** of the esophagus are rarely diagnosed ante-mortem. The symptoms which they cause are of but little con-sequence unless the growth becomes large, when there will be dys-phagia, and at times dyspnea, emaciation, and pain.

These benign tumors include papillomata, fibromata, adenomata, myxomata, myomata, and cystomata.

Papillomata, or warts, may be found in any portion of the canal. They resemble warts of the skin, and are more often found in elderly persons than in young people.

Fibromata, adenomata, myxomata, and myomata usually occur as pedunculated and rarely as sessile growths. They may be found in any portion of the esophagus, but more commonly in the region of the cricoid cartilage. Cases in which the pedicle was long enough to allow the growth to appear in the pharynx during coughing or emesis have been recorded. These growths vary in size from a pea to a body 7 or 8 inches long. They are always much longer than wide. Annandale, James, Rokitansky, Fagge, Coats, Dallas, Bell, Cheatam, and others have reported cases. Cystomata usually consist of small retention-cysts included in a growth of the mucous follicles. They are usually small, although cases in which the cyst became as large as an apple have been recorded.

The *symptoms* of benign esophageal growths are so variable or in-constant that no definite symptoms can be outlined. Large growths which produce no esophageal symptoms during life have been discov-ered after death. In other instances a very small growth has caused marked dysphagia and even dyspnea. If the growth have a long pedicle, the tumor may be forced into the mouth or pharynx during an attack of retching or coughing, and then obstruct the larynx, causing marked dyspnea and death from suffocation.

Diagnosis.—As a rule, the diagnosis of benign tumors of the esopha-gus is made post-mortem. In cases in which there is much dysphagia, especially with periods of intermission, the presence of a benign growth might be suspected. The diagnosis has been accidentally made in the introduction of a parasol-bougie into the esophagus for the purpose of removing a supposed foreign body. In withdrawing the bougie pedun-culated growths have been torn from their attachment and brought out through the mouth. Other cases will show the presence of a growth by its appearance in the mouth or pharynx.

Treatment.—The treatment of benign growths of the esophagus consists in their removal. This may be attempted by means of the bougie, esophagotomy, or gastrotomy when the growth is low down. Cases in which an emetic was administered and the tumor grasped as it was forced into the pharynx by retching have been recorded. The tumor was then ligated and removed, the ends of the ligature being fastened to the ear in order to bring away the stump.

Malignant tumors of the esophagus are either sarcomatous or car-

cinomatous. Sarcomatous tumors are rarely found here. The symptoms in the two classes are practically the same, and the diagnosis of sarcoma is almost invariably made after death, the supposition before death being that the tumor was a carcinoma.

Sarcomata of the esophagus are generally of the round-cell variety, although a combination of round, spindle, oval, and tailed cells was reported in one case. Sarcomata of the esophagus usually develop at the junction of the pharynx and esophagus.
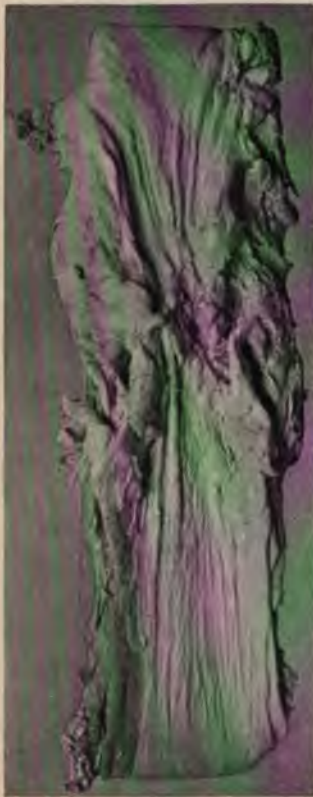
FIG. 96.—Carcinoma of the esophagus.

FIG. 97.—Stricture of the esophagus from carcinoma.

Carcinoma is the most frequent disease of the esophagus (Fig. 96). These growths may occur in any portion of the gullet, authorities differing as to the site of greatest frequency. They are usually primary, and but rarely give rise to secondary infection. At times they result from a primary growth in the mediastinum, stomach, tongue, epiglottis, pharynx, or larynx. Secondary foci are at times found in the left lobe of the liver, the bronchial lymph-glands, or the glands of the stomach. The *etiology* of carcinoma of the esophagus is not well known, but it has been thought due to a predisposition of the tissues

which undergo these changes as a consequence of some mechanical injury to the focus where the growth begins. Possibly the parasitic origin of the growth, in connection with injury or irritation, may account for it.

Carcinomata are found more frequently in men than in women, and in those past the age of fifty than in the young. Mackenzie states that 71 cases out of 100 analyzed by him were males, and that the greater number occurred in those between fifty and sixty years of age. People under twenty and over eighty are rarely affected.

The *pathological changes* which occur during the growth of a carcinoma in the esophagus are not fully known. Three factors are at work from the beginning—growth, destruction, and contraction. The growth extends by induration of the surrounding tissues, and projects into the lumen of the gullet, thus advancing the ulcerated surfaces and partially occluding the lumen. Destruction is often general, or of greater significance near the center of the diseased focus. Disintegration of minute particles may occur, or there may be large sloughs. Ulceration often continues until there is perforation of the wall of the esophagus, with resultant fistulous connection with any of the surrounding structures or cavities. Contraction follows immediately upon destruction, nature causing fibrous changes to take place both in the carcinomatous mass and in the surrounding tissues. Contraction of this fibrous tissue causes constriction of the lumen of the canal, and, in conjunction with the projecting portions of the growth, causes the main symptoms of the affection (Fig. 97).

Symptoms.—The symptoms of carcinoma of the esophagus begin with progressive dysphagia. This is first noticed in taking solid, and later in taking liquid, foods. As the disease progresses, an ulceration and sloughing take place, and there may be a marked amelioration of the dysphagia on account of the increase in the lumen of the gullet consequent upon loosening of the tissues by the ulceration. The dysphagia is generally progressive. In connection with it there will be nausea and vomiting, loss of appetite, occasional regurgitation, progressive emaciation, cough, dyspnea, dysphonia, and dryness of the tongue with excessive thirst. The bowels are generally constipated. These symptoms vary considerably, the dysphagia being at times absent, emaciation being the more prominent symptom. There may be marked lancinating pain, or pain may be entirely absent.

Diagnosis.—The diagnosis is generally made by the above-mentioned symptoms. There will be signs of an obstruction. A bougie should be carefully passed to make certain that an obstruction is present, ascertain its size, and determine its location. At times there will be slight bleeding after the passage of the bougie, which, unless great force has been used, would generally indicate ulceration. During the withdrawal of the instrument, particles of the growth may be torn away. These particles should be examined microscopically to determine the nature of the obstruction. Hitzig, of Zurich, reports that he has observed difference in the pupils in 6 out of 37 cases of carcinoma of the esophagus. In one case the right pupil was larger, the autopsy showing a secondary growth of a gland which was located on the right side of the esophagus and encircled the vessels and nerves. The

other 5 cases showed contraction of the left pupil, which was attributed to deviation of the esophagus to the left. These phenomena are said to be due to pressure upon the sympathetic nerve.

Strictures of the esophagus are divided into spasmodic, cicatricial, and malignant.

Spasmodic stricture of the esophagus, or **esophagismus,** is a purely reflex condition in which there is apparent inability to allow foods to pass through the esophagus. Pronounced nervous symptoms commonly prevail in such cases, and these, in conjunction with some real or supposed disease, cause the reflex condition of the gullet. The

FIG. 98.—Tubercular ulceration of the esophagus producing fistula.

chief cause for the reflex is great excitement brought on by fear, passion, or profound emotion of any kind.

The *symptoms* of esophagismus are generally the same as those of any real stenotic condition of the gullet. There will be inability to swallow food, with all the signs of an obstruction. The attack may soon pass away, but returns at irregular intervals until the cause is removed or the nervous condition improved. As a rule, there will not be as much emaciation in esophagismus as is found when a real stenosis exists; although cases have been reported in which the emaciation was marked, as was shown in the case reported by Pepper. The

dysphagia is generally sudden in onset, and usually occurs while eating; the bolus is regurgitated, occasionally through the nose.

The *diagnosis* is not always easily made. Carcinoma is the affection with which esophagismus is most frequently confounded. The sudden onset in a nervous subject, with periods of freedom from dysphagia, should lead one to suspect esophagismus. An attempt should be made to pass a bougie, at the same time impressing on the patient the amount of good to be accomplished if the bougie pass into the stomach. This procedure will at once clear up the diagnosis.

The *treatment* consists of palliative remedies for the nervous condition, with occasional passage of the bougie for the mental effect, if for no other reason. If there be found any distinct lesion in any part of the system, it should be treated as indications direct. Cicatricial stricture of the esophagus arises from the contraction following traumatism, syphilis, tuberculosis (Fig. 98), or ulcerations. Rarer causes are found in violent and repeated attacks of emesis, in cases where esophagismus has been prolonged and pronounced.

Cicatricial Stricture.—The symptoms of cicatricial stricture of the esophagus vary according to the amount of tissue involved. There is usually increasing dysphagia, which is generally persistent and associated with regurgitation. Emaciation rapidly follows. At times there may be pain, referred to the back, and decided nervous disturbance. If there be involvement of the pneumogastric or inferior laryngeal nerves by induration outside the wall of the esophagus, there will be dyspnea and dysphonia.

The *diagnosis* of cicatricial stricture depends largely upon the history of the case. If no history is obtained which would point to traumatism, syphilis, a foreign body, or ulceration due to destructive liquids taken internally, a diagnosis of malignant stricture will generally be made. With the history of any of the above conditions, and presence of an obstruction determined by the passage of a bougie, the diagnosis is generally positive.

The *treatment* consists of dilatation through the mouth, permanent tubage, retrograde dilatation through the stomach, internal esophagotomy, external esophagotomy, esophagostomy, or esophagectomy. For malignant strictures, see *malignant tumors* (Fig. 97).

Dilatation by Bougies.—This is the treatment to be first tried in all cases of stricture of the esophagus. At first the bougie should be a large one, in order more accurately to gauge the size of the obstruction. If a large one fail to pass, smaller ones must be tried until the bougie has passed into the stomach. If it be impossible to reach the stomach with a bougie, this form of treatment must be abandoned, and one of the other forms adopted. After the proper size bougie has been passed, it should be allowed to remain *in situ* as long as the patient can stand it. In this manner the stricture will be better dilated. Bougies, increasing in size, should be passed according to the amount of resistance found and the irritation caused by the treatment. If there be but little resistance, the bougie should be passed every other day, or two days, unless irritability of the esophagus prevents. When the stricture is hard and resisting, the bougies must be passed less frequently. Each case must be governed by the conditions found.

Permanent tubage of the esophagus for malignant and cicatricial stricture has been practised by various surgeons, but the invention by Symonds, in 1889, of the short tube for this purpose made the operation a practicable one. The introduction and accurate placing of the tube have been greatly facilitated by the invention by Mixter of a measured bougie for locating the stricture and an ingenious introducer

FIG. 99.—Mixter's esophageal instruments.

for placing the tube *in situ.* There is no doubt that with the facilities furnished by these instruments permanent tubage is to be preferred to the repeated passage of bougies, which is attended by pain and hemorrhage. The tube has to be changed only about once in two weeks, and while it is worn the patient is able to swallow with ease and comfort.

By the use of these tubes (Fig. 99) a gastrostomy may often be avoided, the patient being enabled to take sufficient nourishment by mouth as long as life lasts.

External Esophagotomy.—This operation is generally performed through the left side of the neck, on account of the greater accessibility of the gullet here. The skin incision is made along the anterior border of the sternomastoid muscle, and extends from the upper border of the

thyroid cartilage to a point about an inch above the sternoclavicular articulation. Skin, superficial fascia, and the platysma myoides muscle will be divided. If the incision be crossed by the anterior jugular vein, it should be secured between two ligatures and divided. The superficial layer of the deep cervical fascia is then divided, and the anterior border of the sternomastoid muscle freely exposed. The muscle should be drawn outward with hooks, the head being well raised to cause relaxation of the tissues. This will expose the sheath of the vessels, which contains the common carotid artery, internal jugular vein, and pneumogastric. If the omohyoid muscle, which occupies the upper part of this space, cannot be drawn to one side, it should be divided near its attachment to the hyoid bone, division in this place assuring non-interference with the nerve-supply from the descendens noni. The lateral lobe of the thyroid gland, and the sternothyroid and sternohyoid muscles are drawn slightly inward, the carotid sheath outward, and the pretracheal fascia carefully incised. This will expose the trachea, beneath which is the esophagus. The opening into the esophagus should be made between the courses of the superior and inferior thyroid arteries, which is the point of election. If a foreign body be impacted in the esophagus, the center of the incision should be made over the most prominent portion of that body, the arteries being ligated before incising the esophagus, if they be in the way or if there be any fear of hemorrhage. If it be thought advisable to open the gullet on a staff, the latter should be passed through the mouth with its convex surface toward the exposed wall.

The first incision into the esophagus should be a small longitudinal one, the opening being enlarged either with the finger, a pair of scissors, or a pair of dressing-forceps until the required space be afforded. In opening the gullet great care must be exercised to avoid injury to the recurrent laryngeal nerve, which runs between the trachea and the esophagus. Injury to that nerve would cause impairment of the voice.

In closing the wound in the esophagus the mucous membrane and the muscular coat should be sutured separately, as a suture passed through both structures would be likely to cut through. The external wound may be closed, with the exception of a small portion at the lower end to allow for drainage, or, as preferred by some surgeons, it may be packed throughout. The patient should be fed by nutritious enemata for two or three days.

Retrograde Dilatation by Gastrostomy.—The first step in this operation is gastrotomy. When the stomach is exposed, it is drawn into the wound, and opened by a longitudinal incision. Effort should at once be made to pass a bougie from below, through the cardiac orifice and the stricture. If it is possible to pass a bougie through the stricture, a string should be attached to one end of the same and carried into the mouth, through which one end is withdrawn. With the other end of the string protruding through the opening in the stomach, the string is drawn back and forth, producing a sawing motion and dividing the stricture. Further attempts to pass larger bougies should be made until the stricture has been dilated sufficiently to allow the passage of a full-sized bougie from above downward. If the stricture should prove

to be impermeable, then the only resource is the establishment of a gastric fistula, through which the patient is subsequently fed.

Esophagostomy.—The steps in the operation of esophagostomy are the same as those in esophagotomy, until after the opening in the esophagus has been made. When a permanent fistula is to be made, the edges of the esophageal wound are sutured to the lips of the external wound. On account of the depth of the esophagus, it will be impossible to obtain a close coaptation of the edges of the two wounds, so that all that is required is that an opening large enough to admit an esophagotomy tube be secured. After the tube has been passed into the gullet the edges of the skin-wound should be sutured above and below it, in order to prevent any fluids from finding their way into the soft tissues of the neck. Great care must be taken in passing the tube, as there is likelihood of its getting into peri-esophageal tissues and not into the gullet. Solis-Cohen mentions a case where a stiff tube was passed into the mediastinum, the accident being discovered after death. In feeding through an esophagotomy tube, a longer, soft tube should be passed into the esophagus through the esophagotomy tube, in order to make sure that none of the material finds its way into the peri-esophageal tissues.

After the operation has been finished the patient should be kept quiet, and for a few days as little movement of the head and neck allowed as possible.

Esophagectomy.—The esophagus should be exposed in the manner described under esophagotomy. After this has been done the gullet should be separated from the surrounding tissues, and as much of the esophagus removed as is deemed advisable. The end of the lower segment is then brought to the surface and sutured to the lips of the external wound. The operation is not in favor, on account of the poor results which have been obtained. Ashhurst tabulated 8 deaths in 12 cases.

CHAPTER VI.

SURGERY OF THE THORAX.

CONGENITAL MALFORMATIONS.

CONGENITAL malformations of the chest are not of common occurrence, and are few in number. They consist of clefts in the sternum and deficiencies in the chest-wall, owing to the absence or imperfect development of one or more ribs and costal cartilages.

These gaps are more frequently met with on the left side than on the right, and the ribs which have most often been found to be imperfectly developed are the fourth, fifth, and sixth.

INJURIES OF THE CHEST.

Injuries of the chest are divided into those affecting the parietes only and those accompanied by some lesion of the contained viscera. Under the former heading will be described contusions of the chest-wall; fracture and dislocations of the bones and cartilages; and wounds of the chest-wall and diaphragm; under the latter, injuries of the lung and pleura; injuries of the pericardium, heart, and large blood-vessels; and injuries of the mediastinum, esophagus, and thoracic duct.

Contusions of the chest-wall are of frequent occurrence, and are caused by blows or falls upon the chest. The extent of the injury inflicted varies from slight bruising and ecchymosis of the skin and subcutaneous tissue to extensive laceration of muscles, with considerable extravasation of blood into the cellular tissue. These injuries derive their importance, however, from the fact that they are often complicated by fracture of the ribs or sternum, or by some lesion of the thoracic viscera.

Symptoms.—Pain is the most prominent symptom, and is chiefly due to the bruising of the muscles; it is of a sharp, stabbing character, increased by movement, especially such as is occasioned by coughing and sneezing. There is always more or less ecchymosis present, and in some cases very marked swelling occurs, due to extensive extravasation of blood either under the skin or between the muscles. This condition may be followed by suppuration and abscess. Occasionally after a severe contusion of the chest, symptoms of extreme collapse supervene; while in some cases death has occurred instantaneously, though at the post-mortem examination no injury of the viscera has been found to account for the result. To these cases the name "concussion of the chest," "commotio thoracica," has been given.

Concussion of the chest is characterized by the symptoms of shock, more or less severe, coming on immediately after the injury. The patient usually retains consciousness. The surface of the body is

pale, cold, and clammy; the pulse is feeble, and the temperature falls below normal; the respirations are rapid, shallow, and irregular. In the majority of instances the symptoms quickly subside and recovery ensues.

The shock attending concussion of the chest has been explained in several ways. One explanation is that the injury causes direct stimulation of the vagi, and consequent fall of blood-pressure; a second, that the symptoms are due to compression of the heart; and a third, that as the result of the injury the sympathetic is paralyzed, whereby an accumulation of blood occurs in the splanchnic vessels.

Treatment.—In recent cases of contusion of the chest an endeavor should be made to limit as far as possible the extravasation of blood by the application of cold and the use of evaporating lotions during the first few days, and afterward to afford rest to the injured part by strapping the side of the chest. At a later period any pain and stiffness will be rapidly removed by massage and the use of stimulating liniments.

The treatment of shock arising from concussion of the chest consists in placing the patient in the recumbent position with the head low. Warmth should be applied to the surface of the body, and cardiac stimulants should be given either by the mouth or per rectum, while ether and strychnin may be administered hypodermically. When there is severe dyspnea, artificial respiration should be employed.

FRACTURES AND DISLOCATIONS OF THE RIBS, COSTAL CARTILAGES, AND STERNUM. (See Vol. I., Chap. XVI.)

Wounds of the Chest-wall.—Wounds limited to the parietes of the chest, non-penetrating, are most frequently the result of stabs and gunshot injury. They may be either of the incised, punctured, or lacerated variety, and differ in no respect from similar lesions in other situations. They are not, as a rule, serious, though such wounds may be complicated by hemorrhage, the blood escaping either externally or, in the case of a punctured wound, being poured out into the cellular tissue, producing a hematoma. The wound may also become infected with septic micro-organisms, and this may be followed by suppuration and rapidly spreading cellulitis. In all injuries of the chest it is important to determine, if possible, whether the pleura has been injured, and whether any injury has been inflicted on the contained viscera.

The **diagnosis** of wounds of the parietes alone will depend mainly on negative signs; but the nature, situation, and direction of the wound will, in doubtful cases, assist the surgeon in arriving at a definite conclusion.

Treatment.—This consists in the arrest of hemorrhage, the removal of foreign bodies, and the thorough cleansing of the wound. The wound should then be carefully sutured, and if any muscles have been divided, the cut edges should be brought into apposition. Antiseptic dressings should be applied, and kept in place by strapping, as by this means the respiratory movements are limited, and union by first intention is more likely to be obtained. Should suppuration and cellulitis follow, the pus must be evacuated early, and free incisions made if

necessary. The abscess-cavity should be thoroughly disinfected and hot antiseptic fomentations applied.

Penetrating wounds of the chest are far more serious, but the recognition of penetration is often difficult. The symptoms are more severe than when the wound involves the parietes only, and in the majority of cases the patient suffers from shock. When the wound is large, the nature of the lesion is obvious. In other cases air may be heard passing in and out of the wound with inspiration and expiration, blood may be expectorated or may be expelled from the wound by coughing, or hemothorax or pneumothorax may be present, and in such cases the diagnosis is easily made; but when the wound is small and there are no signs of injury to the thoracic viscera, it may be impossible to determine whether the parietal pleura has been penetrated or not. In doubtful cases the wound should be examined carefully with the finger; but great care should be exercised in the use of a probe, and, as a rule, it is better to refrain from using one, as much harm may be done by it.

The **treatment** in the case of a penetrating wound of the chest is to arrest the hemorrhage, cleanse and suture the wound, removing foreign bodies if present, and then to apply a large antiseptic dressing. The patient should be carefully watched lest complications arise.

Wounds of the Vessels of the Thoracic Wall.—Wounds of the intercostal arteries are occasionally met with, but the protected situation of these vessels renders this an exceedingly rare injury. The intercostal arteries have been wounded in the performance of paracentesis thoracis, also during the resection of a rib for empyema; but the injury most frequently arises from stabs and gunshot wounds, while laceration of these vessels has occasionally occurred as a complication of fractured ribs. That this accident is a serious one is proved by the fact that out of 15 cases of this injury which occurred in the American Civil War, 11 terminated fatally.

The effect will be hemorrhage, either internal or external, or both. Where the wound is large, the blood will escape externally; it will be arterial, unmixed with air, and may be observed to flow in a pulsating jet. Where the wound is small, the blood will escape continuously, and not per saltum; while in some cases, especially where the wound is valvular in character, instead of appearing externally the blood may be extravasated into the cellular tissue of the chest-wall.

Internal hemorrhage will occur in cases of small penetrating wounds, where the blood, being unable to escape externally, passes into the pleural cavity.

The recognition of injury to an intercostal vessel is always extremely important, but the diagnosis is often difficult owing to the resemblance which hemorrhage from a wound of one of these vessels bears to that arising from an injury to the lung.

When the lung is wounded, the blood escapes into the pleural cavity and is expelled from the wound at each expiration, the blood being frothy from admixture with air. In some cases the same conditions obtain when the hemorrhage arises from an intercostal artery, the blood being drawn into the thorax at each inspiration, and driven out of the pleura, mixed with air, at each expiration; and, again, a wound of an

intercostal artery may be followed by hemothorax with only very slight external hemorrhage, or it may be complicated by a wound of the lung. When doubt exists as to the source of the hemorrhage, the proper course to adopt is to examine the wound thoroughly, enlarging it if necessary, so as to see clearly if the bleeding vessel be in the parietes.

Treatment.—A wounded intercostal artery should, if possible, be tied, the wound, if necessary, being enlarged.

It is usually impossible to secure the vessel as it lies in the groove on the under surface of the rib, and to overcome this difficulty one of two methods may be adopted; either to resect a portion of rib, or to separate the periosteum from the lower border of the rib, by first dividing the periosteum longitudinally, and then peeling it off the rib with a raspatory; the periosteum will carry the artery with it, and a ligature can then be easily applied.

In cases of emergency, or where from special circumstances ligatures cannot be employed, a tampon may be used as a means of temporarily arresting the hemorrhage. It is applied thus: a square piece of aseptic linen is pushed into the pleural cavity so as to form a pocket, the four corners remaining outside, and the pocket is then tightly packed with gauze. When the corners of the linen are drawn upon, the artery will be compressed against the rib.

Wound of the Internal Mammary Artery.—Wound of this vessel is also an accident of rare occurrence, and when met with is usually complicated by injury to the pleura, lung, pericardium, or heart. It may be caused by stabs and gunshot wounds, and in most cases is accompanied by section of one or more of the costal cartilages.

The symptoms will be those of hemorrhage. In some cases the blood escapes externally; in some it flows into the pleura or pericardium; while in others extravasation takes place into the cellular tissue of the anterior mediastinum.

Treatment.—The proper treatment is to enlarge the wound if necessary, expose the bleeding vessel and tie it, though this proceeding is often extremely difficult, especially if the artery has been wounded where it is covered by one of the costal cartilages. In such a case a portion of the cartilage must be excised in order to secure the vessel.

Wounds and rupture of the diaphragm are caused by stabs and gunshot injury, by contusions of the chest with or without fracture of the ribs, and by sudden increase of intra-abdominal pressure, such as occurs in violent vomiting and during parturition. Owing to the protection which is afforded to the diaphragm by the liver, lacerations of the diaphragm are more frequently met with on the left side. The injury is a serious one, as it is so often associated with some lesion of the thoracic or abdominal viscera.

A wound or rupture of the diaphragm when uncomplicated is not necessarily fatal; but grave symptoms may arise from the escape of some of the abdominal viscera into the pleural cavity, constituting what is termed a *diaphragmatic hernia* (Fig. 100). The stomach, colon, and small intestine are the organs which are thus most frequently displaced.

The hernia may become strangulated, either shortly after the injury or at a more remote period. The contents are not usually contained in a peritoneal sac.

Wounds and rupture of the diaphragm without hernia can hardly be diagnosed except in those rare instances where the rent in the diaphragm can be seen through an open wound.

The **signs** by which a diaphragmatic hernia may be recognized are pain and dyspnea, sometimes accompanied by persistent vomiting. The other signs vary according to the particular viscera that have been displaced. Thus, if the stomach or intestine has been protruded through the rent in the diaphragm, there will be some fulness of the lower part
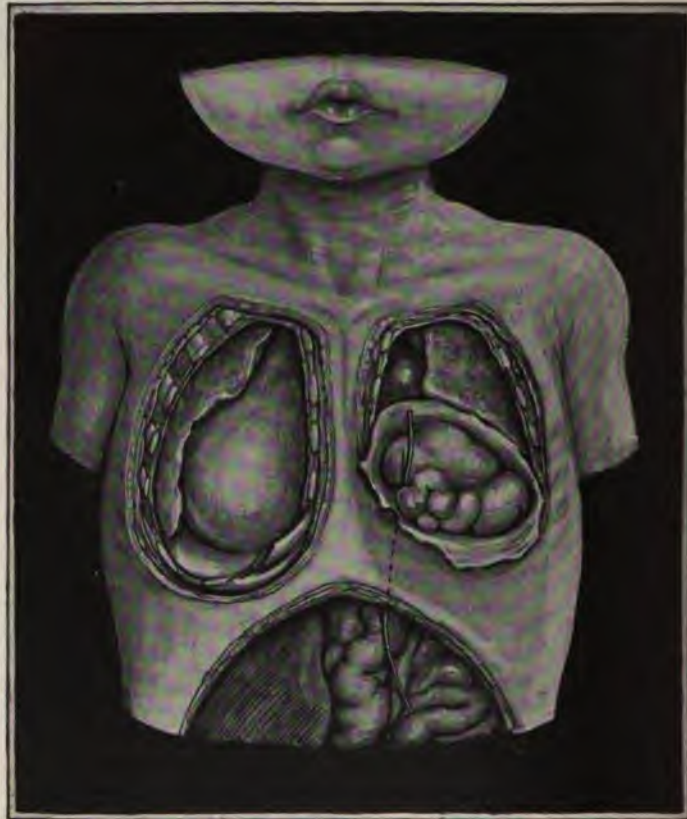
FIG. 100.—Chest of a fetus at full period, showing the relation of parts in a diaphragmatic hernia. On the left side several coils of intestine are protruded through the diaphragm into a sac which reaches as high as the third rib and is separated from the pleural cavity ; the heart is pushed over to the right side (Middlesex Hospital Museum).

of the chest, with tympanitic resonance over that area; possibly a succusion sound may be heard on auscultation, and the normal respiratory murmur will be absent. The heart may also be displaced. Should the hernia become strangulated, the symptoms will be those of internal strangulation.

Treatment.—Wounds of the diaphragm, if the patient's condition admit of it, should be carefully sutured, for as long as the opening persists, there is a tendency to the formation of a hernia and subsequent

strangulation. Diaphragmatic hernia should be treated by immediate operation. Such cases have been successfully treated by laparotomy; but more recently it has been suggested that the best way to reach a diaphragmatic hernia is through the pleura, since it has been found that by resecting portions of several ribs and making a free opening into the pleural cavity, the hernia can be more readily reduced and the rent in the diaphragm more easily sutured.

INJURIES OF THE PLEURA AND LUNG.

Contusion of the Lung.—This may occur as the result of compression of the chest caused by a severe crush or blow, and not infrequently it complicates fracture of the ribs. In contusion of the lung the visceral layer of the pleura remains intact, and blood is poured out into the parenchyma and air-spaces of the lung.

The **symptoms** will vary with the severity of the injury. In mild cases the only indication of contusion of the lung may be the expectoration of a little blood-stained mucus. When the injury is severe, the patient will suffer from pain, dyspnea, cough, and hemoptysis; dulness on percussion will be found over the affected area, and on auscultation coarse crepitations will be heard. These symptoms will be followed after a few days by the expectoration of rusty sputum. Recovery usually takes place, but in elderly people pneumonia sometimes supervenes, which may prove fatal.

Rupture of the lung occurs as the result of violent compression of the thorax. In this injury the lung is torn to a variable extent, and the visceral layer of the pleura is also lacerated, so that blood and air escape into the pleural cavity. The signs of rupture of the lung are similar to those occurring in cases of contusion, but to these must be added evidences of hemothorax and pneumothorax.

The **treatment** of these injuries consists in keeping the patient in bed and absolutely quiet. A careful examination should be made from time to time lest complications arise, the treatment of which will be subsequently described.

Rupture of a bronchus occasionally occurs, usually in conjunction with other injuries. A child was recently admitted into the Middlesex Hospital, having been run over across the chest; death occurred shortly after admission. On post-mortem examination it was found that the right bronchus was ruptured, and there was also a laceration of the middle lobe of the right lung at the anterior margin. The first rib on each side showed a greenstick fracture, and the fourth to the ninth ribs inclusive on the right side were also broken.

Wounds of the Pleura and Lung.—Wounds which penetrate the costal pleura usually involve the lung, but in some cases the pleura may alone be injured. This most frequently happens when the pleura is opened in those situations where the edge of the lung does not quite correspond to the limits of the pleura. In the front of the chest the pleura extends considerably farther over the pericardium than the corresponding lung, and posteriorly the lung does not descend below the tenth rib, while the pleural cavity reaches as far as the twelfth rib or even a little lower.

A patient was admitted into the Middlesex Hospital, having received a bullet wound in the chest. He was markedly collapsed, and there was a wound situated $3\frac{1}{2}$ inches below and a little internal to the nipple. He died on the day following admission. At the post-mortem examination the bullet was found to have struck the seventh rib and to have traversed the pleural cavity without wounding the lung; it had then passed through the diaphragm and wounded the left lobe of the liver.

In fracture of the ribs the parietal pleura may be lacerated, while the visceral layer remains uninjured.

Wounds of the pleura and lung may be caused by stabs with sharp cutting instruments, by gunshot injury, or by the fractured ends of a broken rib, and may therefore be incised, punctured, or lacerated. Of these, punctured wounds such as may be caused by fractured ribs are the least dangerous; they are usually not extensive, and as the air which escapes into the pleural cavity from the lung is free from septic microorganism, decomposition and suppuration do not occur. On the other hand, incised wounds of the lung are very dangerous, as they are often attended by very severe hemorrhage; while gunshot wounds, though the hemorrhage is usually slight, frequently prove fatal from secondary complications, owing to infective matter on foreign bodies having been carried into the lung. The danger and severity of the symptoms will vary according to the extent and situation of the injury. When only the surface of the lung is involved, the symptoms may be very slight; but wounds near the root of the lung are especially dangerous, as the large vessels are likely to be implicated.

There are three conditions likely to occur as the result of a wound of the lung—viz., hemorrhage, the escape of air from the lung, and collapse of the lung.

Hemorrhage may take place into the cellular tissue of the lung, or the blood may be poured out into the air-vesicles or bronchial tubes, and be coughed up; or it may collect in the pleural cavity, constituting hemothorax, or it may escape externally. Air may likewise be forced into the cellular tissue of the lung and mediastinum; it may escape into the pleural cavity, producing pneumothorax, or it may pass in and out of the chest through the wound in the parietes, giving rise to a peculiar hissing or bubbling sound. If the external wound is small and oblique, or if the injury to the lung has been caused by a fractured rib, the air may escape into the subcutaneous cellular tissue, producing more or less extensive emphysema (Fig. 101).

Collapse of the lung does not always occur even when the pleural cavity has been freely opened, and this circumstance is no doubt due to the cohesion existing between the two moist pleural surfaces.

Marked collapse of the lung is most likely to occur in small valvular wounds of the parietes and lung accompanied by the escape of air and blood into the pleural cavity. When adhesions exist between the lung and parietal pleura at the seat of injury, collapse of the lung obviously cannot take place.

Symptoms.—These necessarily vary, and will depend upon the situation, extent, and nature of the injury. Collapse is usually present, often to a marked degree; this may be due to the shock which accompanies a wound of any important organ or to loss of blood.

The symptoms pointing more directly to wound of the lung are dyspnea, the respirations being at the same time rapid, shallow, and almost entirely abdominal; pain in the chest, and a constant hacking cough, which the patient endeavors to suppress on account of the pain. Hemoptysis is often present; this may consist merely in the expectoration of frothy blood-stained mucus, or the hemorrhage may be abundant; there may also be an escape of blood and air from the wound.   In addition to these symptoms there may be evidences of hemothorax, pneumothorax, or emphysema, followed at a later period by pleurisy,

FIG. 101.—General emphysema from a fractured rib.

pneumonia, or empyema.   When the wound is large, prolapse of the lung may occur.

The **prognosis** even in a case of uncomplicated wound of the lung is necessarily grave; but the danger in each particular case will depend upon the depth and size of the wound, the part of the lung wounded, and the nature of the instrument with which the injury was inflicted. A wound of the lung may prove immediately fatal from the severity of the hemorrhage, or from blood escaping into the bronchial tubes and causing asphyxia.   Death may also ensue at a subsequent period from septic inflammation of the lung or pleura.   Wounds involving both lungs nearly always prove fatal, but cases have been recorded in which even after such an injury patients have recovered.

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Treatment.—The patient should be placed in bed, on the injured side, and kept absolutely quiet. In most cases it is better for the surgeon to refrain from making a complete examination at first. Means must be taken at once to arrest the hemorrhage. The wound should be examined with the finger, and any foreign bodies that can be easily extracted should be carefully removed, but no prolonged attempt at removal should be made. The surface of the wound and the surrounding skin should be thoroughly cleansed with an antiseptic solution, such as carbolic-acid lotion (1 : 20), and the wound itself may be swabbed out, but irrigation should not be employed.

When the wound is large and clean cut, the divided structures should be united by sutures; but when the wound is contused or lacerated, such as might be caused by a bullet or some blunt instrument, it should, after being cleansed, be left open, and a drainage-tube inserted if necessary. It should then be covered up with a large antiseptic dressing kept in place by broad strips of strapping firmly applied, so as to restrain as far as possible the respiratory movements. At first the patient will be in a state of collapse, and as this condition favors the arrest of hemorrhage, it is well not to interfere; great care must therefore be exercised in the administration of restoratives.

The patient should be kept in the recumbent position, absolutely quiet, and in a cool room. All excitement should be avoided, and he should be forbidden to speak. Later he should be given small pieces of ice to suck, or small quantities of iced milk and soda water to drink.

The amount of food given during the first three days should be very limited; and if the patient is very restless, morphin may be administered with beneficial effect. After three days, if no complications arise, the quantity of food may be gradually increased.

Complications of Injuries of the Lungs.—The following immediate complications may occur—viz., hemorrhage, emphysema, pneumothorax, prolapse of the lung, and the retention of foreign bodies.

Hemorrhage.—One of the principal dangers arising from a wound of the lung is hemorrhage. This varies in amount within very wide limits, and depends upon the nature and situation of the wound. When only the surface of the lung is injured, the hemorrhage may be very slight, while wounds near the root of the lung may give rise to profuse bleeding, which rapidly proves fatal.

Where there is an open wound the blood will escape externally, but when the wound is small or oblique, or when the injury to the lung has been caused by the fractured end of a rib, the blood will collect in the pleural cavity, producing hemothorax. In the majority of cases of wound of the lung hemoptysis occurs, the blood escaping into the air-spaces or smaller bronchial tubes and being coughed up. Each of these conditions must be considered separately.

External hemorrhage arising from a wound of the lung is characterized by the escape of blood and air from the wound during expiration, while the other signs of injury to the lung will point to the source of hemorrhage. The difficulty that may arise in distinguishing between bleeding from a wound of the lung and that occurring from

an injury to the intercostal or internal mammary vessel has already been referred to (page 188).

Hemothorax, or hemorrhage into the pleural cavity, may occur as the result of an injury to the lung; it is also met with as the result of a wound of an intercostal or internal mammary artery, either by a penetrating wound of the chest or by a fragment of a broken rib. It is more likely to occur where the external wound is small, for when the wound is large, the blood escapes externally; when it occurs as a complication of fractured ribs, there is usually no external wound.

The *symptoms* of hemothorax are loss of movement of the affected side; dulness on percussion over the lower part of the chest, coming on shortly after the injury, and rapidly increasing; and impairment of vocal fremitus and vocal resonance, with absence of the respiratory murmur over the area of dulness. When the effusion takes place rapidly, there will be signs of severe internal hemorrhage—viz., marked collapse, pallor of the surface with clammy perspiration, restlessness, thirst, a small, thready pulse, and great dyspnea. There may also be noted enlargement of the affected side of the chest and bulging of the intercostal spaces.

Blood, when effused into the pleural cavity, may remain fluid for a considerable time; more usually, however, it speedily coagulates. Unless septic matter has been introduced into the pleura the blood is finally absorbed, though absorption does not take place so rapidly as in the case of a serous effusion. Should the clot become invaded by septic micro-organisms, it rapidly decomposes, setting up acute inflammation of the pleura, terminating in empyema.

Hemoptysis is characterized by the expectoration of light-red blood, frothy from the admixture of air. In some cases it is slight in amount, while in others it is very profuse. This is usually followed in a few days by the expectoration of sputum of a rusty character.

Treatment.—In the case of hemorrhage occurring from a wound of the lung, the surgeon's first object should be to diminish the force and frequency of the heart's action, and thus favor the coagulation of blood in the vessels. The patient should be placed in bed, and on the injured side, with the head and shoulders slightly raised. He should be kept absolutely quiet and free from all excitement; he should be encouraged to suck small pieces of ice, and an ice-bag should be applied to the chest. Hemostatics, such as ergotin, injected subcutaneously may be tried. If the patient is very restless, a hypodermic injection of morphin (gr. $\frac{1}{6}$) should be given.

When the blood is escaping externally, the parietal wound should be closed, after the parts around have been carefully cleansed and covered with an antiseptic dressing. The dressing is best kept in place by broad strapping firmly applied, as this helps to immobilize the injured side of the chest, while at the same time the movement of the sound side is not interfered with.

When the blood collects in the pleural cavity, giving rise to hemothorax, if the effusion is so great as to threaten death from suffocation by pressure on the lung, the wound must be opened up, or a free incision must be made into the pleural cavity and the blood allowed to escape. It is only under such exceptional circumstances that it will

be necessary to interfere; as a rule, the hemorrhage soon ceases, and the effused blood is quickly absorbed. If septic matter has been introduced into the pleura, the blood will decompose; the absorption of the septic toxins will speedily give rise to symptoms of acute inflammatory fever, and, unless a free exit is afforded to the pent-up pus, signs of septic poisoning will rapidly supervene. In such a case the pleural cavity must be opened in a dependent position, all blood-clot removed, and free drainage established. When severe hemoptysis occurs after a wound of the lung, rest, the application of ice to the chest, the administration of small pieces of ice to suck from time to time, and opium internally, are the means most to be relied on.

Several cases have been recorded where persistent hemorrhage, after a wound of the lung, has been treated by operation. Opinions differ at present as to the advisability of interfering in these cases, but should all other means fail to arrest the hemorrhage, the surgeon must be prepared to open up the wound freely, and endeavor to control the bleeding, either by plugging or by suturing the wound in the lung.

Emphysema, or the infiltration of air into the cellular tissue, is a frequent complication of wounds of the lung; it may occur with or without pneumothorax. Emphysema is often met with in cases of fractured ribs; in such cases it is usually localized, is not associated with pneumothorax, and very rapidly disappears. The occurrence of emphysema without an accumulation of air in the pleural cavity may be explained in two ways: either the lung has been injured at a spot where adhesions exist between the parietal and visceral layers of the pleura, or the natural cohesion of the two moist pleural surfaces prevents their separation, and the air traverses the pleural cavity, but without accumulating in it, and passes into the cellular tissue of the chest-wall. Very extensive emphysema sometimes follows a simple fracture of the ribs, and is then almost always complicated by pneumothorax. In penetrating wounds of the chest, with injury to the lung or bronchi, especially if the wound is small and oblique, emphysema is very likely to occur; but when the wound is large, not valvular in character, and when the external opening corresponds to that in the lung, emphysema will not take place.

Emphysema occasionally arises in cases of penetrating wounds of the chest-wall, without any injury to the lung, where the air enters the chest from without at each inspiration, and is forced out of the pleural cavity during expiration. If the wound in such cases is of a valvular nature, the edges tend to fall together at each expiration, and the air being unable to escape externally passes into the cellular tissue.

Lastly, in rupture of the lung without laceration of the visceral layer of the pleura, air may escape into the connective tissue of the lung; it then passes by the root of the lung and superior mediastinum into the cellular tissue of the neck, and diffuses itself over the body.

The *symptoms* of emphysema consist of swelling of the affected part, commencing at the seat of the lesion (except when the emphysema is due to subserous rupture of the lung, when the swelling first becomes apparent at the root of the neck), and then gradually increasing in all directions.

The skin over the affected area is normal in appearance. The

swelling is soft and elastic, and yields a very characteristic crackling sensation when gently pressed upon. It is usually limited to the upper part of the trunk and neck, but in rare cases the emphysema may extend all over the body, causing great embarrassment to the respiration, and if not relieved it may prove fatal from suffocation.

The *prognosis* is usually favorable, the air, even in cases of extensive emphysema, rapidly becomes absorbed, without showing any tendency to excite inflammation.

Treatment.—When the emphysema is localized, no special treatment is required, and all that is necessary is to fix the affected side of the chest by means of strapping or a bandage. If the emphysema is spreading rapidly and becoming general, causing embarrassment to the respiration, multiple incisions through the skin are indicated.

Pneumothorax, or the presence of air in the pleural cavity, may result from a penetrating wound of the chest, or from an injury to the lung without any external wound, as in cases of fractured ribs. In the former case the lung collapses, and air is drawn into the pleura at each inspiration; but as long as the wound remains patent, the air is able to escape freely during expiration, so that the pressure on the lung never reaches such a degree as to cause serious interference with the respiration. Cases in which both pleural cavities are opened, and in which pneumothorax occurs on each side, though not necessarily fatal, are always very serious.

When pneumothorax arises from a wound of the lung without any external injury, air passes into the pleural cavity, and being unable to escape, it accumulates there, causing the lung to become collapsed and compressed, so that the respiration becomes greatly embarrassed. The air is usually rapidly absorbed, and it is only when associated with an external wound that there is any tendency for traumatic pneumothorax to be followed by inflammation and suppuration.

Symptoms.—The symptoms of pneumothorax are mainly those of pressure on the thoracic viscera—viz., dyspnea and orthopnea. There is diminished movement of the affected side of the chest, and in extreme cases unilateral enlargement and obliteration of the intercostal spaces may be observed, while the heart may be displaced to the opposite side. On percussion the note is tympanitic; the respiratory murmur may be distant, absent, or amphoric in character, and the bell-sound will be heard when one coin is struck against another pressed flat against the chest. When, in addition, there is fluid in the pleural cavity, there will be dulness on percussion over the base of the lung; metallic tinkling and the succussion splash may also be audible. The prognosis in each case will depend on the nature and severity of the injury to the lung.

Treatment.—As the air in cases of pneumothorax is usually rapidly absorbed, and shows no tendency to excite inflammation and suppuration unless septic matter has been introduced at the time of the injury, no special treatment is required. Should the respiration, however, become greatly embarrassed, owing to the increased thoracic pressure, and death be threatened from suffocation, the pleural cavity should be tapped with a trocar and cannula, every antiseptic precaution being carefully observed.

Prolapse of the lung through a wound of the chest-wall is an extremely rare complication of penetrating wounds of the chest. It may occur at the time of the accident or shortly after the infliction of the injury, and may or may not be complicated by a wound of the pro-truded portion of lung. It is most likely to occur when the wound in the chest-wall is of considerable size; the lower intercostal spaces and the anterior and lateral regions of the chest are the situations in which this complication is most frequently met with. The prolapse occurs as the result of a forced expiratory effort at the moment of the receipt of the injury; the glottis being closed, the lung is thereby compressed, and tends to escape in the direction of least resistance. The prolapsed portion of lung is at first normal in appearance, smooth on the surface, and crepitates on pressure; but as it is tightly constricted at its base, it soon becomes congested and swollen, while ultimately it may pass into a gangrenous condition and slough off. In other cases the lung shrinks, granulations spread over the surface, and, finally, cicatrization takes place. If seen shortly after the occurrence of the accident, the lung can, as a rule, be easily returned into the thorax; but soon adhe-sions form between the parietal and visceral layers of the pleura, and the herniated mass becomes irreducible. The prognosis is these cases is generally favorable.

Treatment.—If the patient is seen soon after the receipt of the injury, an attempt should be made by careful manipulation to return the prolapsed portion of lung into the pleural cavity, and, if necessary, the opening in the chest-wall should be enlarged sufficiently to allow of its reduction. The wound should then be closed. If it is found impossible to reduce the hernia, or if the lung is intensely congested and unlikely to recover, or if it has already become gangrenous, it had better be left *in situ* and the slough allowed to separate by the natural process. The separation may be facilitated by excising the prolapsed portion after applying a ligature to its base.

Foreign Bodies.—Penetrating wounds of the chest complicated by the presence of foreign bodies are always serious, and the danger in such cases arises from the fact that infective material is very frequently carried into the wound, and speedily sets up inflammation and sup-puration. Bullets and fragments of clothing, etc., may become lodged in almost any part of the chest; they may remain in the pleural cavity or may enter the lung. In the former case the foreign body may fall to the lowest part of the pleura, and, if no infective material has been introduced, may become encysted; but more frequently it excites inflammation and suppuration, resulting in a localized abscess or empyema.

When the foreign body lodges in the lung, the effect produced will also depend on the introduction of septic matter. If the foreign body is aseptic, and if infection has not been conveyed by the wound, a sim-ple localized inflammation will be set up, resulting in the formation of fibrous tissue, so that the substance may ultimately become encapsuled. But if the foreign body is septic, or if septic matter is introduced through the wound, acute inflammation and suppuration are certain to follow. The pus thus formed may be discharged through the wound, and the foreign body may escape at the same time. In other cases the

abscess may burst into a bronchial tube, when the pus will be expectorated, or rapidly spreading septic pneumonia may supervene and speedily prove fatal.

Treatment.—The wound should be carefully examined with the finger or, if necessary, by means of a probe. This examination should be conducted with the utmost gentleness, and, if the foreign body is not readily detected, the search for it should not be prolonged. If the foreign body is plainly felt, an attempt should be made to extract it, otherwise the surgeon must desist from further examination and await results. A difficulty which frequently arises in the treatment of these cases is due to the impossibility of determining the exact position of the foreign body. This difficulty, in the case of bullets and metal substances, has been to a great extent removed by the discovery of the Röntgen rays; but, even after the seat of the foreign body has been accurately localized, the question will naturally arise whether it would be prudent to attempt its removal, and in arriving at a definite conclusion on this point every case must be judged on its own merits.

The *secondary complications* likely to follow a penetrating wound of the chest with injury to the lung are pleurisy and empyema, pneumonia, and pneumocele or hernia of the lung.

Pleurisy and Empyema.—Localized inflammation of the pleura may follow a subcutaneous injury to this membrane, as in cases of fracture of the ribs; or it may occur as the result of a penetrating wound caused by a clean instrument. The inflammation is in these cases limited in extent; it leads to the formation of adhesions between the two pleural surfaces, sometimes to a localized serous effusion, and almost invariably terminates favorably. On the other hand, when the wound of the pleura has been caused by a septic instrument, or when a foreign body is present and pyogenic organisms have been introduced into the pleural cavity, an acute inflammation is set up which spreads rapidly and very soon involves the whole surface of the pleura. The effusion which is poured out is at first serous, but quickly becomes purulent. In cases where there is a large open wound, the pus thus formed will escape externally; but where the wound is small or valvular in character, or where the edges have been closely united by sutures, the inflammatory products will collect in the pleural sac.

The physical signs of fluid in the pleura are diminished movement of the affected side of the chest, with dulness on percussion, gradually increasing from below upward, loss of vocal fremitus and vocal resonance over the region corresponding to the dull area; while on auscultation the breath-sounds will be either absent, or distant and tubular in character. When the effusion is great, the heart may be displaced to the opposite side of the chest, and there will be marked dyspnea.

The constitutional signs in the early stage will be those of acute inflammatory fever, due to the absorption of the products of putrefaction, and unless a free exit is afforded to the pent-up pus, these will be followed by symptoms of septic poisoning and, possibly, by those of pyemia.

Treatment.—When the inflammation of the pleura is simple and localized, no special treatment is required. If suppuration occurs, the treatment consists in the early and complete evacuation of the inflam-

matory products. The wound should be enlarged, a portion of rib excised if necessary, and the contents of the pleura thoroughly cleared out. The cavity should then be carefully cleansed by means of antiseptic swabs, and free drainage provided. Where the wound is not in a dependent position, or when the cavity cannot be efficiently drained through the original wound, a counter-opening should be made, after which a full-sized drainage-tube should be introduced and a large antiseptic dressing applied.

Pneumonia.—Traumatic pneumonia is a frequent complication of wounds of the lung. Its severity varies within very wide limits. In its mildest form the inflammation is limited to the immediate neighborhood of the wound; it has little or no tendency to spread, and the inflammatory products speedily undergo resolution. In other cases, where the injury has been inflicted by a septic instrument, or when foreign bodies, such as portions of clothing, have been carried into the lung, owing to the presence of septic organisms the extravasated blood quickly decomposes, and the products thus formed excite an acute inflammation of the surrounding tissue. Even under these circumstances the process may remain localized; sometimes the inflammation extends very rapidly, speedily running on to suppuration and ending in gangrene of a portion of the lung. The pus from an abscess thus formed in the lung may be discharged externally, it may escape into a bronchus and be expectorated, or it may burst into the pleural cavity.

Symptoms.—The symptoms of traumatic pneumonia will depend on the nature of the inflammation, whether simple or septic, and the amount of lung-tissue involved.

Simple localized traumatic inflammation will cause but slight constitutional disturbance, while the physical signs will in most cases be obscured by other conditions, such as pneumothorax and hemothorax. Spreading septic pneumonia, on the other hand, is characterized by grave constitutional symptoms; the temperature rises to 103° or 104° F., the pulse is rapid—120 or 130—and there is severe local pain. The expectoration, which is at first bright red, soon becomes rust-colored, and there is marked dyspnea. On examination the ordinary signs of pneumonia may be detected—viz., dulness, increased vocal fremitus and vocal resonance, bronchial breathing, and fine crepitation, though not infrequently these signs are obscured by the presence of fluid in the pleural cavity.

The *prognosis*, which, as a rule, is favorable, will depend upon the amount of lung-tissue involved and on the presence or absence of a foreign body. Traumatic pneumonia shows but little tendency to spread, and in this it differs essentially from the idiopathic form.

Treatment.—In the first place this must be expectant, in the hope that the inflammation may resolve. The patient should be kept in bed at perfect rest and in a warm moist atmosphere. His strength must be supported by light, nourishing liquid diet, and stimulants should be given if necessary. Should an abscess form in the lung, the cavity should be opened and drained if its position can be localized, a portion of rib being removed if necessary.

Consecutive Hernia of the Lung.—This term is applied to that

variety of hernia where the protrusion of the lung occurs some weeks after the receipt of an injury.

The hernia may be the result of the yielding of a cicatrix after a penetrating wound of the chest has healed, or it may, more rarely, follow a subcutaneous injury involving fracture of several ribs. The chest-wall is consequently weakened at one spot, and the pressure from within during forced expiration, as in coughing, causes a gradual yielding of the wall and the protrusion of a portion of the lung.

Consecutive hernia occurs more frequently in males than in females, and the most common situation for hernia to occur is in the anterior part of the chest, in the fourth or fifth interspace.

Signs.—The protruded portion of lung is covered by normal integument, but it frequently becomes adherent to the skin, so that complete reduction is impossible. The swelling is soft, crepitant to the feel, circumscribed, and elastic; sometimes it is reducible on pressure. It increases in size during expiration and diminishes on inspiration. It is resonant on percussion, and on auscultation the respiratory murmur is louder than normal. The prognosis in these cases is favorable.

Treatment.—This consists in reducing the hernia, if possible, and keeping it reduced by means of a carefully adjusted pad.

When the protruded portion of lung cannot be returned into the thorax, it should be protected from injury and prevented from increasing in size by the application of a hollow padded truss.

INJURIES OF THE PERICARDIUM, HEART, AND LARGE VESSELS.

Injuries of the Pericardium.—Contusion or laceration of the pericardium may be produced by a severe crush of the chest. More frequently injury to this membrane is caused by the sharp end of a fractured rib, or by penetrating wounds of the chest, such as stabs and gunshot wounds.

Such injuries rarely occur alone, and are usually complicated by wound of the heart or large blood-vessels. In other cases wounds of the pericardium are associated with injury to the lung and pleura.

Symptoms.—Collapse is usually the most prominent symptom in these injuries, and if the patient survives, it is soon followed by the signs of pericarditis—viz., friction, irregular action of the heart, small quick pulse, and considerable dyspnea. The area of cardiac dulness may be increased, and this, if coming on shortly after the receipt of the injury, is due to effusion of blood; when it appears at a later period, it is due to the accumulation of serum or pus in the pericardium.

The **diagnosis** of an injury of the pericardium when produced subcutaneously can only be made after the onset of pericarditis; but when the injury has been caused by a wound, the size, situation, and direction of the wound, as well as the nature of the instrument with which the wound was inflicted, will aid the surgeon in arriving at a definite conclusion. Except in the case of a large wound, it must necessarily be impossible to distinguish between a simple uncomplicated wound of the pericardium and one associated with a superficial wound of the heart. The prognosis is grave, though recovery is not infrequent.

Treatment.—The patient should be kept absolutely quiet, and

every precaution taken to prevent septic infection of the wound.   The
surrounding parts should be carefully cleansed, the wound closed, and
dressed antiseptically.   If signs of pericardial effusion supervene, and
if the fluid by its pressure is causing serious interference with the
heart's action, an aspirating needle should be introduced in the fifth
left interspace and the fluid withdrawn.   Should this prove to be puru-
lent, the pericardium should be opened and drained.

Injuries of the Heart.—**Rupture of the heart** (see also Vol. I.,
Chapter XXVII.) may be caused by forcible compression of the chest,
and may occur with or without fracture of the ribs or sternum.   In the
majority of cases when rupture of the heart occurs, the pericardium
is also lacerated, while not infrequently the internal structures—the
valves, septa, or chordæ tendineæ—are torn.   The injury is more liable
to affect the right side of the heart than the left, and the different cavi-
ties of the heart are involved in the following order of frequency—the
right auricle, left ventricle, left auricle, and right ventricle.

The injury is almost always immediately fatal, the patient dying
either from shock or from the rapid effusion of blood into the pericar-
dium and consequent interference with the heart's action.

Wounds of the heart are most frequently the result of stabs and
gunshot injury, but they may also be produced by the end of a broken
rib, and in exceptional cases the heart has been injured by foreign
bodies which have been swallowed and have perforated the esoph-
agus.

Wounds of the heart are divided into penetrating, or those that in-
volve one of the cavities of the heart, and non-penetrating, or those in
which the parietes alone are injured.   The majority of cases fall under
the former heading, non-penetrating wounds, according to Fischer,
amounting to not more than 9 per cent. of all wounds of the heart.

A non-penetrating wound of the heart may vary in degree from a
slight abrasion of the surface to a wound extending almost through
the entire thickness of the cardiac wall.   The hemorrhage attending
such an injury is usually less than in a penetrating wound, and the
prognosis is more favorable; but fatal consequences may follow, death
occurring from shock or from hemorrhage resulting from wound of
one of the coronary arteries, followed by an accumulation of blood
in the pericardial sac and pressure on the heart.   The effects of a
penetrating wound of the heart will vary according to the size and
nature of the wound, but much will also depend on its situation and
direction.

Wounds of the auricle are more rapidly and more frequently fatal
than wounds of the ventricle, while recovery has most often followed
injuries of the apex of the heart.   Longitudinal wounds are said to be
less serious and to be attended by less severe hemorrhage than wounds
which are transverse in direction.

With regard to the relative frequency with which the different
regions of the heart are involved, statistics show that wounds of the
ventricles are far more common than wounds of the auricles, and that
the right ventricle is more often injured than the left.

Penetrating wounds of the heart often prove immediately fatal, death
occurring from shock or from loss of blood, but many instances are

recorded where patients lived for a considerable period after the receipt of such an injury. According to Fischer's statistics, out of 401 cases of wounds of the heart there were only 43 recoveries, or 10.7 per cent.

Should the injury not prove rapidly fatal, secondary complications—pericarditis, myocarditis, and endocarditis—are likely to follow and lead to the death of the patient; at a later period yielding of the scar and secondary rupture of the heart may occur. In several cases a wound of the heart has been followed by cerebral embolism.

Foreign bodies may lodge in the muscular tissue of the heart or in one of the cavities of the organ, and may remain encapsuled for years. Of these, bullets and needles are the most common, but fish-bones and splinters of wood have also been found embedded in the substance of the heart. Foreign bodies usually enter the heart through the thoracic wall; more rarely they gain entrance by ulcerating through from the esophagus or bronchial tubes.

Symptoms.—Collapse is usually present to a marked degree, and is accompanied by symptoms of severe hemorrhage. The hemorrhage may be either external or internal, or blood may be poured out in both directions. When the external wound is large, the quantity of blood lost may be very great; in other cases, as when the wound is small and oblique or valvular in character, very little blood will escape externally, but blood will accumulate in the pericardium or pleura, or it may find its way into the mediastinum.

The patient is usually seized with a feeling of intense anxiety almost immediately after the accident, and is very restless. Dyspnea is often a marked symptom, though in some cases it may be entirely absent; the pulse is feeble, irregular, and intermittent, and may become almost imperceptible at the wrist. The heart's action is tumultuous, weak, and irregular. The area of cardiac dulness is increased, and if there is much effusion of blood, the sounds may become inaudible. Later, if the patient survive, these symptoms may gradually subside, or inflammatory complications—pericarditis or endocarditis—may supervene.

Treatment.—The patient should be placed at once in the recumbent position and kept absolutely at rest. All excitement should be avoided, and every endeavor made to prevent the onset of, or to arrest, internal hemorrhage. Very small quantities of liquid nourishment should be given at first, but the patient may be allowed to suck small pieces of ice. Stimulants should, of course, not be given. If the patient complains very much of thirst, this should be relieved by enemata rather than by the administration of large quantities of fluid by the mouth. If he is very restless, morphin should be given hypodermically, and he should be kept under its influence for several days.

The wound should be closed after the parts around have been rendered aseptic, and dressed antiseptically.

The danger in these cases is often due to the pressure exercised on the heart by the accumulation of blood in the pericardium. When, therefore, the symptoms point to interference with the heart's action by the pressure of extravasated blood, the question of opening the chest and the pericardium and removing the clot will have to be considered.

Suture of wounds of the heart has been shown, by experiments on dogs, to be possible.

The procedure has been adopted in several instances, and recently a case was recorded in the *Lancet*,[1] in which Parrozzoni of Rome successfully sutured a wound in the left ventricle.

The patient, a porter aged thirty-two, was stabbed in the seventh left interspace in the midaxillary line. Shortly after the receipt of the injury he showed symptoms of excessive hemorrhage. An incision was made, 1¼ inch from the margin of the sternum in the fourth intercostal space, for 5½ inches, and from the outer end of that incision a second was made at right angles to it in the midaxillary line, as far as the ninth rib. The pleura was divided in a horizontal direction at the level of the fourth space, and the fifth, sixth, seventh, and eighth ribs with the pleura attached were cut through vertically and the flap raised. The cavity of the pleura was found to be filled with blood, and a wound 1 inch in length was discovered in the pericardium. This was enlarged to 2½ inches. There was only a small amount of blood in the pericardial sac ; this was removed, and a wound was then seen near the apex of the heart ¾ inch long, from which blood escaped at each beat. A finger introduced passed into the left ventricle.

Four sutures, not passing through the endocardium, were inserted to close the wound in the wall of the ventricle ; the flap was replaced and sutured in position. The wound healed by first intention, and the patient made a good recovery.

Injuries of large vessels of the thorax are caused in the same way as injuries of the heart. The aorta or vena cava may be partially ruptured or torn completely across by a contusion of the chest ; wounds of these vessels may be caused by stabs or gunshot injury. Such lesions are attended by signs of severe internal hemorrhage, and are usually immediately fatal.

Injuries of the Mediastinum.—Contusion of the mediastinum may occur as the result of fracture of the sternum, or injury may be caused by penetrating wounds.

In the latter case some of the important structures contained in the mediastinum are usually implicated, such as the heart, large bloodvessels, esophagus, or thoracic duct. Air may pass into the cellular tissue, having gained access either through the wound or by escaping from the lungs or bronchial tubes in cases in which these structures have been injured. In the former case the extravasation is always limited ; but in the latter the air may pass upward into the root of the neck and give rise to extensive emphysema. Effusion of blood is the complication most likely to follow a wound of the mediastinum. When small in amount the blood soon becomes absorbed ; but if septic matter has been introduced, it will excite inflammation, suppuration, and mediastinal abscess.

The **treatment** of wounds of the mediastinum consists in closing the wound, as in similar injuries occurring in other parts of the chest, keeping the patient absolutely quiet in the recumbent position, and avoiding all possible sources of septic infection.

Mediastinal Abscess.—Inflammation of the cellular tissue of the anterior mediastinum and mediastinal abscess may follow as the result of a penetrating wound, where septic matter has been introduced.

The **symptoms** of mediastinal abscess are pain, tenderness, and increased heat of the part, with rise of temperature ; there may also be a distinct swelling at the side of the sternum, with edema of the skin. The respiration is often very much embarrassed, dyspnea coming on in paroxysms, especially when the patient is in the recumbent position.

[1] 1897, vol. ii., p. 260.

There may be dulness on percussion over the front of the sternum, and evidence of compression of the heart and large blood-vessels, such as palpitation and edema. The abscess may burst externally, or it may open into the pericardium or pleura; in other cases the pus may find its way into the trachea, and cause death from asphyxia. When the abscess presents externally, it usually points just outside the left edge of the sternum.

Treatment.—As soon as the condition is recognized, a free exit should be afforded for the pus. The sternum should be trephined if necessary, the abscess-cavity explored with the finger, and thorough drainage provided.

Injuries of the Esophagus.—Rupture of the esophagus has occasionally occurred as the result of violent vomiting; in these cases the lesion is always situated near the cardiac orifice of the stomach.

Wound of the esophagus in the mediastinum may be caused by external injury. Such an accident is rare and is usually complicated by injury of other organs. More frequently the esophagus is wounded from within. The walls may be perforated by a fish-bone, or by foreign bodies which have been swallowed and have become impacted in the gullet. Injury may also be caused by attempts to remove a foreign body from the esophagus or in passing an esophageal bougie.

The **symptoms** are pain and difficulty in deglutition, and when there is an external wound, food will be seen issuing from it. Inflammation of the cellular tissue of the mediastinum and suppuration are very likely to follow when the wound involves the whole thickness of the wall, and if the lung has been injured, pleurisy and pneumonia are almost certain to supervene.

Treatment.—When there is reason to suspect that the wall of the esophagus has been perforated, the patient should be fed entirely by nutrient enemata and nutrient suppositories for a fortnight, until the wound has had time to heal.

In the case of an external wound a free exit should be afforded for anything which may escape from the esophagus. Should signs of inflammation supervene, these must be treated on ordinary principles.

Injury of the Thoracic Duct.—The thoracic duct may be wounded at the root of the neck or in the thorax. It has been divided by gunshot wounds and stabs, and it has also been injured during performance of operations on the neck. Rupture may also occur from external violence. The injury is recognized, when a wound is present, by the copious discharge of chylous fluid, which coagulates spontaneously. The fluid is milky during digestion, but becomes clear during fasting. When there is no external wound, the fluid may collect in the pleural cavity. The injury is frequently fatal, death occurring from inanition.

Keen of Philadelphia has recorded a case in which the thoracic duct was injured during the performance of an operation on the neck. The opening in the duct was sutured with fine silk and the patient recovered. Nine cases of operative injury of the duct have been reported, with 8 recoveries, so that the injury is not so serious as it was formerly regarded.

DISEASES OF THE CHEST-WALL.

Caries and Necrosis.—Caries of the ribs, sternum, and costal cartilages is not infrequently met with, and is usually of tuberculous origin; it may also arise in consequence of syphilis. Necrosis may occur from the same causes, or it may follow upon injury, such as a blow on the chest. Sometimes necrosis is met with as a sequel to one of the acute specific fevers, especially typhoid.

Usually an abscess forms, which, if the necrosis is of tuberculous or syphilitic origin, is chronic in character; but when it arises from one of the other causes, the abscess may be acute. The pus may make its way to the surface, or may burrow inward, setting up inflammation of the pleura or lung.

When suppuration occurs in connection with caries of the sternum or costal cartilages, the inflammation may extend to the mediastinum, giving rise to a mediastinal abscess.

The **treatment** consists in opening the abscess, scraping out the abscess-cavity, removing any sequestra or carious bone that may be present, lightly packing the cavity with iodoform gauze, and allowing it to granulate from the bottom.

When the disease is syphilitic in origin, potassium iodid in full doses should be given.

Tumors of the Chest-wall.—These may be either simple or malignant. Of the simple tumors, lipomata situated in the subcutaneous fatty tissue are the most common. Fibromata and fibroneuromata, the latter in connection with one of the intercostal nerves, occasionally occur. Chondromata may grow from the sternum or ribs. These tumors may consist almost entirely of cartilage, but frequently they are mixed tumors, containing sarcomatous elements; they have in some cases been observed to follow an injury. Osteomata grow from the bony wall of the thorax.

Of the malignant tumors, sarcoma and carcinoma may both occur. *Sarcomata* may arise from the ribs and sternum or from the other tissues entering into the formation of the chest-wall. In other cases the growth commences in the interior of the chest, and involves the chest-wall secondarily. Those tumors which spring from the ribs and sternum may be endosteal or periosteal. They usually grow very rapidly, and soon give rise to secondary deposits.

Carcinomata affecting the chest-wall nearly always originate in the breast. The treatment of tumors of the chest-wall consists in the complete removal of the growth. When the tumor is situated in and limited to the superficial structures, this can be easily accomplished. When the tumor springs from bone or has formed secondary attachments to the bony framework of the thorax, the operation becomes much more difficult. In such cases, if the growth has not advanced too far, removal should be attempted; but the surgeon must remember that it is sometimes impossible to ascertain beforehand the exact limits of the growth. In some cases it may be necessary to resect several ribs, with or without a portion of the sternum. The danger to be feared in such a procedure is the possible opening of the pleural cavity, with the attendant shock and collapse. Parham of New Orleans, in a recent

exhaustive monograph, has collected all the reported cases of resection of the thoracic wall for the removal of tumors. In 52 cases out of 78 the pleural cavity was opened. Figs. 102 and 103 show one of his cases before and after operation.

Gummata of the chest-wall are frequently met with, and are important on account of their liability to be mistaken for sarcomata. They may develop in the subcutaneous tissue or may occur in connection with bone, often coming on after an injury. Like gummata elsewhere, they soon soften and break down, leaving a deep excavated ulcer. Under the administration of potassium or sodium iodid gummata rapidly disappear, or if ulceration has occurred, healing quickly takes

FIG. 102.—Parham's case of chondrosarcoma, before operation.

place. In the latter case some mercurial application should be used locally.

Actinomycosis involving the chest-wall is occasionally met with. It commences either in the lungs, pleura, or liver, and spreads thence to the chest-wall. When the chest-wall becomes involved, an indefinite swelling forms, which may easily be mistaken for a tubercular abscess. If the swelling is left to itself, the skin over it becomes red and gives way, a small quantity of watery pus being discharged. Ulceration occurs around the sinus thus formed, which becomes surrounded by prominent granulations. In this granulation-tissue can be seen small pale-yellow granules, which, if examined microscopically,

will be found to contain mycelium with club-shaped bodies, character-istic of the disease. Other swellings soon appear, which run a similar course.

If the swelling is incised before the skin gives way, it will be found to consist mainly of granulation-tissue, only very little pus escaping at the time.

Treatment.—Potassium iodid in large doses is the drug which has given the best results. The surgical treatment consists in scraping out

FIG. 103.—Parham's case; front view, after operation.

the sinuses and removing all the granulation-tissue, provided that the disease has not extended beyond the limits of practical surgery.

Subphrenic Abscess.—This term is applied to those abscesses which commence beneath the diaphragm and subsequently invade the pleura.

The causes of subphrenic abscesses are various; thus, they may arise from perforation of an ulcer of the stomach, duodenum, or trans-verse colon; others originate from the cecum, vermiform appendix, liver, or spleen. When the abscess is extraperitoneal, it will probably have started from the kidney, vertebræ, or ribs. In some instances the abscess has originated inside the chest.

The **symptoms** will vary according to the origin and situation of the abscess. The ordinary signs of abscess may be present in some cases; in others the abscess-cavity may contain gas, and the symptoms

will then resemble pneumothorax. The heart may be displaced and the liver may be pushed downward.

The abscess, if left to itself, nearly always proves fatal.

The **treatment,** after the diagnosis has been verified by the introduction of an aspirating needle, consists in the complete evacuation of the pus; thorough drainage should be provided, a portion of rib being excised if necessary.

OPERATIONS ON THE CHEST.

Exploratory puncture of the chest is a procedure which is resorted to for the purpose of ascertaining the presence of fluid in the pleural cavity, and also of determining the nature of the fluid. With proper care it is an operation absolutely devoid of danger. It should be used as a means of clearing up the diagnosis in doubtful cases, and should always be adopted in any case of suspected empyema previous to the performance of an operation for the evacuation of the pus.

For this purpose an ordinary hypodermic needle is often employed, but it is preferable to use an aspirating needle. The advantages of the latter are that it is longer and stronger; a needle of greater caliber can be used, which is less likely to become blocked by flakes of lymph; while if the fluid is serous, aspiration can at the same time be performed, and if it prove to be purulent, the pleural cavity can be partially emptied, should it be considered advisable to do so.

Exploration can be safely performed almost anywhere within the limits of the pleura, but the puncture should not be made too low down lest the diaphragm be injured. In localized collections of fluid the puncture must be made over the center of the suspected accumulation; but in other cases the sixth or seventh interspace in the mid-axillary line may be conveniently chosen, or exploration may be performed more posteriorly at a spot immediately below and anterior to the angle of the scapula, though this situation has the disadvantage that here the ribs are more thickly covered by muscle.

The skin should always be thoroughly cleansed, first with soap and water and then with carbolic-acid lotion (1 : 20). The syringe or aspirator should be rendered aseptic by being soaked in carbolic solution, while the needle is best sterilized by boiling or by passing it through the flame of a spirit-lamp.

The spot for puncture having been chosen, the surgeon feels for the space between two ribs, and entering the needle over the upper border of the lower rib bounding the intercostal space, introduces the needle with a sharp thrust through the thoracic parietes, so as to avoid the possibility of pushing the pleura, which is often very much thickened, before the needle, and so failing to enter the pleural cavity. The extent to which the needle is introduced must be regulated by the forefinger, placed at a suitable distance from the point. On withdrawing the piston the fluid, if present, will be sucked up into the syringe. After the needle has been withdrawn the puncture should be immediately covered with a collodion dressing. The operation is attended by such a slight amount of pain that it is unnecessary to freeze the part or to inject cocain.

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Paracentesis Thoracis.—This is required for the relief of serous pleural effusion and empyema, but aspiration in cases of empyema does not often effect a cure. It is only in children that such a favorable result is likely to follow, and then the operation has, as a rule, to be repeated several times. Moreover, the proportion of cases in which a cure has been effected by this means is so small that time should not be lost in attempting this, before proceeding to drain the pleura cavity.

In cases of extensive empyemata aspiration is undoubtedly followed by beneficial results by affording relief from pressure, especially when the effusion is on the left side and is causing displacement of viscera, with embarrassment to respiration and circulation. In such cases incision and drainage of the pleural cavity are always attended with risk to the patient, and the danger of the operation is considerably diminished if some of the fluid is drawn off twenty-four hours previous to the performance of thoracotomy.

As in the case of exploratory puncture, the best situation for performing paracentesis is in the sixth or seventh intercostal space in the midaxillary line. It is important to prevent the entrance of air into the pleura during the performance of the operation. Numerous means of accomplishing this have been devised, but the instrument most usually employed is the bottle-aspirator. The syphon-aspirator may also be used, but the fluid runs away more slowly by this means, and hence the operation is rendered more tedious.

The patient should be brought to the edge of the bed and placed in the recumbent position. The skin around the spot chosen for puncture having been rendered thoroughly aseptic, and the instruments having been sterilized, the needle or trocar and cannula is introduced in the manner described in the previous section. It is not necessary to administer a general anesthetic; but should the patient be very nervous, the skin may be sprayed with ether or chlorid of ethyl.

The fluid should be drawn off slowly, so as to allow the displaced viscera to accommodate themselves gradually to the relief of pressure caused by the removal of the fluid. Should the flow suddenly cease, probably the mouth of the needle or cannula has become blocked by a mass of coagulated lymph. The lumen of the tube should then be cleared by the introduction of a stylet. Aspiration should at once be discontinued (1) should syncope occur, (2) should the fluid become blood-stained, or (3) should the patient suffer from a constant irritating cough.

It is not necessary, nor indeed is it possible, to draw off all the fluid from the pleural cavity, and the removal of part of the fluid favors absorption by the pleura, so that in the case of a serous effusion the fluid remaining behind after aspiration is usually rapidly absorbed.

As soon as the needle has been withdrawn the puncture should be sealed over with a collodion dressing. Should the fluid reaccumulate, the operation must be repeated, and if the contents of the pleura become purulent, incision and drainage are indicated.

Incision and Drainage of the Pleural Cavity.—As soon as the presence of pus in the pleura has been determined, there should be

no delay in removing it, as serious consequences may follow. Death may occur from compression of the lungs or heart, or from septic poisoning. In some cases an empyema, if untreated, points externally, usually in the front of the chest, in the fifth interspace; in other cases the pus burrows beyond the limits of the pleura in various directions, finding its way downward underneath the diaphragm into the iliac fossa, or it may burst into the lung.

Another result which may follow, if operation be long delayed, is that the lung becomes so compressed and so firmly bound down by adhesions that even after the pus has been evacuated the lung is unable to expand. In such cases the cavity remains unobliterated, and may continue to discharge pus indefinitely unless some further operation is undertaken (see Thoracoplasty).

Position of the Opening.—The opening may be made either at the level of the fifth or sixth rib immediately in front of the posterior axillary fold, or opposite the eighth or ninth rib below and a little external to the angle of the scapula. The latter situation is to be preferred, inasmuch as it affords more efficient drainage, the opening being situated just above the attachment of the diaphragm to the ribs and at the most dependent part of the pleural cavity, when the patient is in either the upright or the recumbent position. The former situation possesses one advantage, which is that the operation can be performed while the patient is lying on his back; and in cases of large empyemata with considerable displacement of the thoracic viscera, since turning the patient on to his sound side greatly increases the risk of the operation, this is a matter of considerable importance. But as previously stated, in such cases it is infinitely safer to relieve the intrathoracic pressure by aspiration of the chest as a preliminary measure, and to open and drain the pleural cavity at a subsequent period.

The fact that in the anterior operation the incision lies in front of the latissimus dorsi, and therefore does not necessitate the division of so thick a layer of muscular tissue, is of little consequence, compared with the advantage gained by the more efficient drainage which the posterior opening affords.

In cases of localized empyema the incision should be made a little below the center of the area of dulness.

The Anesthetic and Position of the Patient.—Chloroform should always be employed in preference to ether. The latter frequently sets up violent coughing and causes the patient to struggle just as he is going under the anesthetic; while in some cases alarming dyspnea occurs from the accumulation of mucus in the bronchial tubes, owing to the excessive secretion which occasionally results from the administration of ether.

The patient should be drawn well over to the edge of the table and allowed to lie as much as possible on his back. It is better not to turn him completely over on to the sound side, for this position may cause serious interference with the respiration. The arm should not be raised to more than a right angle, and should not be drawn forward over the front of the chest, as by so doing the skin will be displaced and the incision will consequently be of a valvular character—a condition which may cause great inconvenience in the after-treatment.

If the surgeon prefers it, the patient may be placed on the affected side and turned slightly on to his face, the operation being performed from behind.

Resection of Rib.—Most surgeons at the present time resect a portion of rib. The older method consisted in making an opening through one of the intercostal spaces, usually either in the fifth or sixth space in the midaxillary line. This method is no doubt simpler and can be performed more rapidly, but it can only be satisfactorily carried out in cases where the intercostal space is wide, while the subsequent falling together of the ribs may cause so much narrowing of the opening as to render the subsequent drainage extremely unsatisfactory.

Also, on account of the close proximity of the ribs to one another posteriorly, the opening into the pleura has to be made in front of the posterior axillary fold when the incision is made through an intercostal space, and hence in a position less likely to secure efficient drainage.

The advantage gained by resecting a portion of rib is that a freer opening is obtained, which enables the surgeon to remove any masses of lymph that may be present, and to explore the cavity thoroughly with his finger. A large drainage-tube can be introduced and is not compressed by the ribs, and the opening can be made in the most favorable situation. No evil consequences follow the removal of a piece of rib. New bone is rapidly formed, and, as a rule, the continuity of the rib is restored. Necrosis to a limited extent may occur, but this is rare.

Steps of the Operation.—The skin having been thoroughly cleansed and rendered aseptic, an incision 3 inches in length is made over the ninth rib, parallel to its long axis. The center of the incision should correspond to a point just outside the angle of the scapula. The tissues are rapidly and evenly divided until the rib is exposed for the entire length of the incision. The wound is held open by means of retractors and the periosteum divided. This is then separated from the outer surface of the rib with a raspatory, a scalpel being used to divide the attachment of the intercostal muscles at the upper and lower borders of the rib, if necessary. The periosteum is detached from the posterior surface of the rib with a slightly curved, blunt raspatory, and by so doing the intercostal vessels and nerve will be easily turned out of the groove along the lower border of the rib.

The raspatory should be passed completely behind the rib and the periosteum separated for 2 inches. The denuded portion is then cut away by means of a suitable pair of bone-pliers, or a deep groove may be made in the rib with a small saw, and the section completed with forceps.

All hemorrhage should be arrested before the pleura is opened. This is done by pushing a steel director through the periosteum and pleura, or the periosteum may first be divided with a scalpel. A pair of sinus-forceps is now passed along the groove in the director into the pleural cavity, and the blades widely opened, when the pus at once escapes. In cases of extensive effusion it is advisable that the pus should be allowed to drain away slowly, for the sudden relief of tension which occurs when the pus is rapidly evacuated is liable to induce syncope.

The finger should be introduced into the pleura to ascertain the size of the cavity, its exact situation, and also the condition of the lung. In an empyema of long standing the lung will feel firm and non-crepitant. It will be bound down by dense adhesions, and will show very little tendency to expand; while in cases of recent origin, as soon as the pus has escaped, the expansion of the lung may be so complete as to cause obliteration of the greater part of the pleural cavity.

When the pleura has been freely opened, the patient should be rolled over on to his back, so as to facilitate the escape of pus. All masses of coagulated lymph should be removed with forceps, and the cavity gently wiped out with aseptic wool swabs.

There is a difference of opinion among surgeons as to the advisability of washing out the pleura. Some surgeons hold that it is an unnecessary and dangerous procedure, while others consider that it is desirable to cleanse the cavity thoroughly at the time of the operation. Grave and even fatal consequences have followed irrigation, and, if efficient drainage be provided, the discharge soon loses its fetid odor, and irrigation will very rarely be required. If it is considered advisable to wash out the pleura, boric-acid lotion or some other mild antiseptic fluid should be used, at a temperature of 100° F. The lotion should be allowed to flow in gently from an irrigator, which should not be raised more than 2 feet above the level of the table; and a second tube, larger than the one attached to the irrigator, should be introduced into the pleura, so as to afford a free exit for the fluid and to avoid the possibility of a sudden increase of pressure by the accumulation of fluid in the pleura. After all the fluid has run out, the cavity should be gently dried.

A single opening is usually sufficient to secure thorough and efficient drainage, but should it prove to be inadequate, a counter-opening should be made in a suitable position. This is easily accomplished by introducing a stout probe and cutting down on the end, which is made to project through one of the intercostal spaces, and then resecting a portion of rib, if necessary.

A large drainage-tube should be introduced. The simplest and most convenient form is a flange rubber tube without lateral holes. To the flange tapes are attached on either side, and these are passed round the chest and tied. The diameter of the tube should not be less than $\frac{1}{2}$ inch. The tube should be sufficiently long to enter the pleural cavity, but it should not project far into it. One or two silk sutures may be inserted at each angle of the wound.

The dressing should consist of some antiseptic absorbent material. Of these the double cyanid gauze is one of the best. Several layers of gauze should be placed next the wound underneath the flange of the tube, and over this an abundant dressing of the same material, which should extend well beyond the tube on all sides. The outer part of the dressing should consist of sal alembroth wool, and the whole be kept in place by a flannel binder.

After-treatment.—As a rule, the discharge after the operation is copious, and it is usually necessary to change the dressings twice a day for the first few days. As the discharge diminishes, changing the dressings once in twenty-four hours or even less frequently will suffice. If

the discharge continues to be profuse, or if it become offensive, gentle irrigation with some bland antiseptic lotion may be tried; but in most cases both of these conditions are due to inefficient drainage, and are best treated by making a counter-opening.

The time at which the tube may safely be left out varies considerably in different cases. Drainage is usually required for a longer period in adults than in children, for in the young, expansion of the lung often takes place very rapidly. The best guides as to when the tube should be removed are the quantity and the character of the discharge. When the discharge is small in amount and merely serous, the tube may safely be removed; but if its removal is followed by a rise of temperature, or if the discharge should again become purulent, the tube should be replaced.

After the operation the general health must be attended to and the patient's strength must be supported, while his diet should be light and nutritious. He should be kept in bed for the first week or ten days, and after that period, if the temperature is normal, he may be allowed to sit up.

In the later stages change of air, if possible, to the seaside, will be beneficial, and this is especially indicated in those cases in which a sinus persists for some time after operation. It is also desirable that the expansion of the chest should be assisted by the performance of respiratory gymnastic exercises, such as blowing water through tubes from one bottle into another, the object of these exercises being to induce forced expiration. In addition to increasing the capacity of the thorax, they also diminish the tendency toward the production of lateral curvature of the spine, which sometimes occurs as a sequela of empyema.

Results.—The results of the operation are usually satisfactory. The temperature falls to normal after the evacuation of the pus, and if the cavity is thoroughly drained it seldom rises again.

In children especially the prognosis is favorable, and, other things being equal, the earlier the case is subjected to operation, the more rapid and the more complete will be the expansion of the lung, and therefore the more readily will a cure be effected. The process of cure is brought about by the obliteration of the pleural cavity, mainly by the expansion of the lung and the formation of adhesions between the parietal and visceral layers of the pleura, but partly also by the ascent of the diaphragm and by the falling in of the chest-wall.

Treatment of Double Empyema.—In cases of empyema occurring on both sides, Pearce Gould recommends that aspiration should first be tried, and if that fails to effect a cure, that the two pleural cavities should be drained.

The two sides should not be opened at the same time, but an interval of a few days or a week should be allowed to elapse between the two operations. Gould records a case of this kind under his own care treated in this manner, in which complete recovery followed.

Thoracoplasty.—In some cases fistulæ, often very difficult to heal, persist after an operation for empyema. This may be due to several causes:

1. A sinus may be prevented from healing by the prolonged reten-

tion of a drainage-tube. In such a case the external opening should, if necessary, be enlarged and the sinus thoroughly scraped out. It should then be lightly packed with iodoform gauze and washed out daily with some stimulating lotion. The sinus will then, as a rule, quickly close.

2. More frequently the condition is due to imperfect drainage, the opening into the pleura not being situated at the most dependent part of the cavity. Here a second opening must be made, and after a free drain has been provided the cavity will soon heal.

3. Necrosis of a rib may be the cause of a sinus persisting, and as soon as the sequestrum is removed or comes away, the discharge ceases and the wound heals.

4. The most serious condition, and one sometimes extremely difficult to cure, is that dependent on the presence of a cavity, often of considerable size, existing between the two layers of the pleura, which persists on account of the imperfect expansion of the lung on the one hand, and on the other the failure of the chest-wall to fall in.

In such cases where the lung has ceased to expand, when the chest-wall has fallen in to the full extent, and when a cavity still remains, thoracoplasty should be performed. It is not an operation to be lightly undertaken, and should be resorted to only after a fair trial has been given to the other methods of treatment; after a sufficient length of time has elapsed to allow those changes to occur on which the healing of an empyema depend; after change of air, if possible residence in high altitudes, combined with suitable respiratory exercises, has failed to produce any appreciable diminution in the size of the cavity; and always provided that the patient is otherwise in fairly good health and free from tubercular disease. Such cases, if left, must inevitably terminate fatally, death occurring from some intercurrent affection or from albuminoid degeneration of the viscera.

The operation aims at removing all the rigid wall bounding the cavity, so as to allow the soft parts entering into the formation of the chest-wall to come into close contact with the collapsed lung. The extent and severity of the operation must therefore vary directly in proportion to the size of the cavity.

Estländer, whose name is associated with this operation, recommended subperiosteal resection of all the ribs entering into the formation of the outer wall of the cavity; yet in cases of long-standing empyema and in those occurring in elderly patients, it has been found that the removal of the ribs alone is not sufficient to effect a cure, but that the removal of the periosteum and the thickened pleura is also necessary.

Before commencing the operation the cavity should be carefully explored with a probe, so as to ascertain its limits, and the ribs to be resected should then be exposed by a free incision. This may be done by a vertical incision over the center of the cavity, or if only a portion of two or three ribs require to be removed, a single incision over the central rib will give sufficient room. When the cavity is large, it is better to expose the ribs by raising a large flap containing any muscles which overlie the ribs.

The incision recommended by Schede commences at the edge of

the pectoral muscle, above the level of the fourth rib. It is carried in a curved direction downward to the lowest part of the pleural cavity, and then upward along the vertebral border of the scapula. All the structures are divided down to the ribs, and the flap consisting of skin and muscle is rapidly raised. Whichever incision is employed, when the ribs are exposed the periosteum of each is divided and separated from the bone for a distance corresponding to the extreme limits of the cavity. The denuded portions of ribs are then cut away with bone-forceps. Whether it is considered advisable to take away the periosteum or not, the resection of the ribs should be subperiosteal. By adopting this method not only can the ribs be more easily removed, but the hemorrhage at this stage of the operation is also diminished.

The ribs from the second to the ninth may have to be removed in this way if the cavity is extensive, each rib being divided anteriorly at its junction with the costal cartilage, and posteriorly as far back as the tubercle.

The periosteum and thickened pleura, together with the intercostal muscles bounding the cavity, are next cut away with scissors, the intercostal vessels being ligatured as soon as they are divided. The division of these structures should be commenced posteriorly, so as to diminish the hemorrhage from the intercostal vessels.

The inner wall of the cavity should be scraped with a sharp spoon, and all the unhealthy granulation-tissue lining the interior should be removed. The cavity should then be cleansed, either by careful irrigation or by the use of antiseptic swabs.

The flap is next replaced and sutured in position, a large drainage-tube being introduced at the most dependent part of the cavity, and an abundant antiseptic dressing applied.

Healing in these cases is usually tedious, suppuration continuing for a period of six months or a year until the soft parts have fallen in completely. Great difficulty may be experienced in obtaining obliteration of the upper part of the cavity, a space which is bounded by the first or upper two ribs being left. In such cases Godlee recommends making an opening through the first or second intercostal space.

Pneumotomy.—This operation is required in cases of abscess of the lung, gangrene of the lung, and hydatid disease; more rarely it is undertaken for the purpose of opening and draining bronchial dilatations and tuberculous cavities. Pneumotomy for the latter two conditions has not yielded favorable results, for in both affections the cavities are usually multiple, and although one of these may be opened and drained, the disease still progresses, and little permanent benefit is derived from the operation.

Steps of the Operation.—The exact position of the cavity should be ascertained by making an exploratory puncture with an aspirating needle. Chloroform should be administered, but the patient should not be brought deeply under the influence of the anesthetic. The patient should be placed as much as possible on his back, and in some cases it is advisable to lay him on the affected side, the operation being performed from behind.

On no account should the patient be turned completely over on to the sound side, for by so doing the fluid contained in the cavity may be

discharged into a bronchus and give rise to asphyxia, while a similar complication may arise during the operation from the passage of blood into a bronchial tube.

The aspirating needle being used as a guide, a portion of one or two ribs should then be removed in the manner previously described, and the parietal pleura exposed, which should be carefully divided.

In chronic cases adhesions usually exist between the two layers of the pleura; but if no adhesions are present, as is sometimes the case when the cavity is of recent origin, the lung should be at once sutured to the parietal pleura. A pair of sinus-forceps is next passed into the lung along the side of the aspirating needle or cannula, and the opening enlarged by expanding the blades. The operation has also been performed in two stages in cases where adhesions had not formed between the lung and pleura, the lung being first stitched to the parietal pleura, and the cavity opened two or three days later after adhesions had formed. When the pus has escaped, the finger should be introduced and the abscess-cavity explored as far as possible. A flange drainage-tube should then be inserted and an antiseptic dressing applied. If the hemorrhage from the lung is severe, the wound may be plugged with iodoform gauze.

As regards the treatment of hydatid disease of the lung, aspiration sometimes succeeds in effecting a cure; but it must be remembered that this simple operation has proved fatal, owing to the rapid escape of fluid from the cyst into the bronchioles, causing asphyxia. When, therefore, hydatid disease is suspected, pneumotomy should be at once performed.

Pneumonectomy.—The apex of the lung has been excised for tuberculous disease, and portions of the lung involved in new growth have also been removed, the affected part being cut away after applying ligatures beyond the limits of the disease. In other cases the removal has been effected by means of the cautery.

Tubercle sufficiently advanced to justify operation being rarely limited to one lung or to one portion of the lung, and the diagnosis of growth in the early stage (the only time at which removal by operation is possible) being so difficult, it can hardly be expected that the operation will be found applicable in many cases.

Paracentesis Pericardii.—This operation is required in cases of hydrops of the pericardium, when the effusion has persisted in spite of treatment, or when the pressure of the fluid is so great as seriously to threaten the life of the patient. The situation usually chosen is the fifth intercostal space, 1 inch to the left of the sternum, so as to avoid wounding the internal mammary artery, and also to avoid opening the pleura. The operation may also be performed through the fourth intercostal space. An aspirator is the most convenient instrument to use. The patient should lie as nearly as possible in the recumbent position. The skin having been cleansed and the needle rendered aseptic, a small incision is made with a scalpel and the needle introduced near the upper border of the sixth costal cartilage. It is then passed slowly onward until the fluid appears in the aspirator. After the fluid has been withdrawn, the needle is removed, and the puncture covered with a gauze and collodion dressing.

Drainage of the Pericardium.—Cases of purulent pericarditis must be treated like an empyema, by incision and drainage. This can be done by an incision in either the fourth or fifth intercostal space, or by excising the fifth costal cartilage. Care must be taken not to wound the internal mammary artery.

The pericardium should be exposed, and after all hemorrhage has been arrested, should be carefully incised with a scalpel and the opening enlarged with a probe-pointed bistoury. After the interior has been cleansed, the pericardium should be sutured to the margins of the wound, a large drainage-tube inserted, and an antiseptic dressing applied.

The incision for drainage of the pericardium is best made from the middle of the sternum outward over the fifth costal cartilage to its

Incision for resection of fifth costal cartilage.
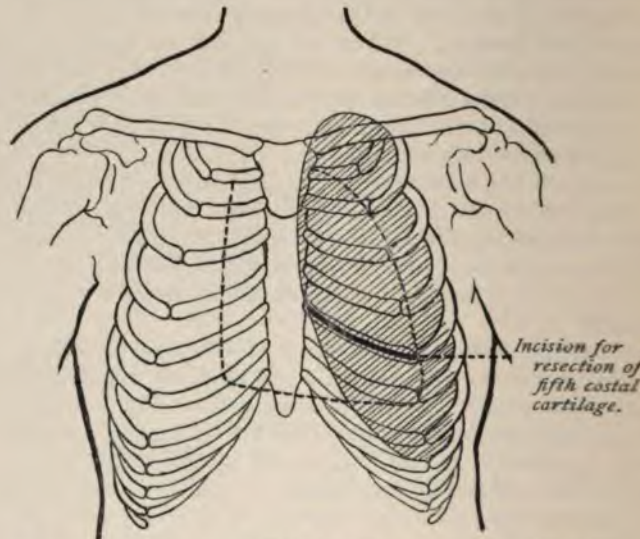
FIG. 104.—Showing incision for resection of fifth costal cartilage. The shaded area represents the left pleura ; the dotted line, the border of the pericardium.

junction with the rib (see Fig. 104). This incision, followed by resection of the cartilage and incision of the pericardium close to the border of the sternum, best avoids opening the pleura. The incision in the pericardium is carried obliquely downward and outward from the external border. (See Vol. I., p. 881.)

Paracentesis of the heart has been recommended and practised in cases where the right side of the heart has become engorged owing to obstruction to the circulation through the lungs, and when the patient's life is in danger on account of the overtaxed condition of the heart. Either the right auricle or right ventricle may be tapped. The right auricle may be reached by introducing a fine trocar and cannula through the third interspace, close to the right margin of the sternum, and the ventricle may be tapped through the fourth right interspace, 1 inch from the sternum.

Opening the Posterior Mediastinum.—It has been suggested

that the posterior mediastinum should be opened for the purpose of removing foreign bodies from the esophagus or bronchi, should all
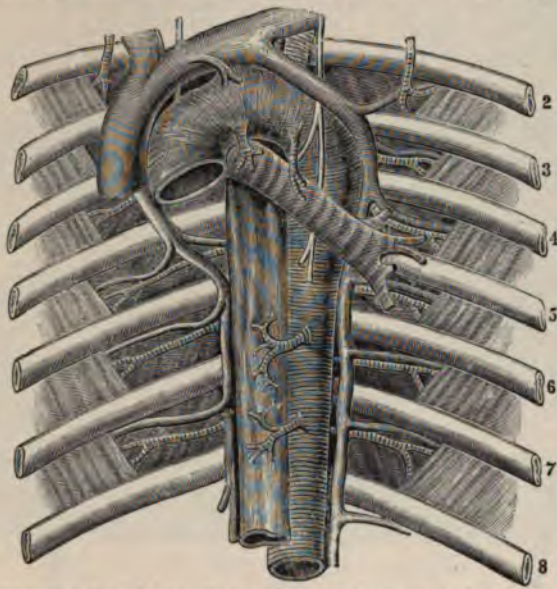
FIG. 105.—Showing the relation of the esophagus to the aorta below the arch; the intercostal vessels and the venæ azygos, and the relations of each to the ribs, intercostal tissues, esophagus, etc. (Bryant).

other means of extracting them fail; also to afford an exit for pus, as in abscess of the mediastinum or in the case of a suppurating lymphatic

FIG. 106.—Showing the flap turned across the spine to the left side, and the divided extremities of the three ribs (fourth, fifth, and sixth). The fragment of the middle (fifth) is removed, and the other two (fourth and sixth) are severed and turned upward and downward respectively, the intercostal tissues between them and the contiguous ribs being intact, and the vascular supply unimpaired (Bryant).

gland. Tumors of the mediastinum rarely admit of surgical interference.

Bryant[1] describes in detail the steps of the operation.

The left side should in most cases be selected as being the more convenient (Fig. 105). The situation of the obstruction having been as far as possible ascertained, a flap is raised 3 inches square, including all the tissues down to the ribs, and extending from the spinous processes to the inner border of the scapula. Portions of not less than three ribs should be displaced from the angles to the outer extremities of the transverse processes, so as to afford sufficient room. The soft parts should be carefully reflected from the middle rib, exposed, and
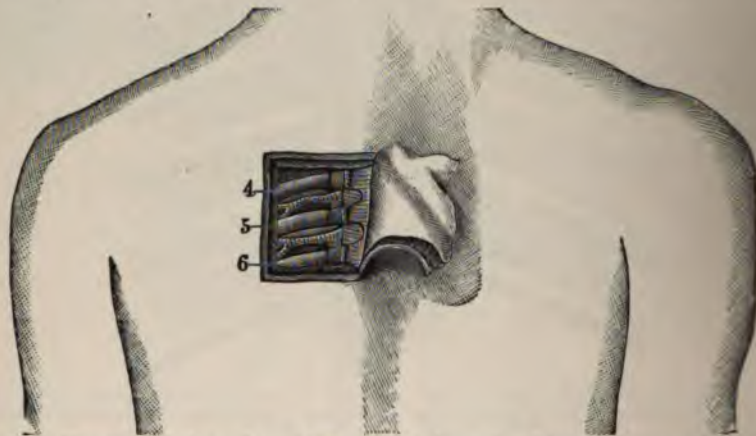
FIG. 107.—Showing the three ribs and the associated vessels. The flap, composed of all the tissues down to the ribs, is reflected across the spine (Bryant).

the pleura separated from its anterior surface. The rib should then be divided in two places and a portion removed (Figs. 106, 107).

With the finger the pleura should be detached from the rib above and the one below the opening; the intercostal vessels are next ligatured and the soft parts divided. The ribs from which the pleura has been detached are then cut across and turned upward and downward. All hemorrhage should be carefully arrested at each step of the operation.

The obstruction is then sought for with the finger. The portion of the middle rib which has been removed is not replaced. The two other ribs are sutured in position, the flap is replaced, and dressings are applied.

ARTIFICIAL RESPIRATION.

In surgery the chief use of artificial respiration occurs in cases of asphyxia during anesthesia and in the resuscitation of the apparently drowned. In apnea, or arrested respiration from any cause, the oxygenation of the blood in the quickest way is the chief thing to be considered; and this is best obtained by forced movements of the arms and thorax, to secure inspiration and expiration of air in the largest volume possible.

Sylvester's method of artificial respiration, with slight modifica-

[1] *Trans. Amer. Surgical Assoc.*, 1895.

tions, should be used in all cases, for careful experiment has proved that it effects the greatest interchange of air in the lungs. The essentials of this method are as follows:

Inspiration is secured by raising the arms in a line with the body above the head, thus raising the ribs and clavicles and enlarging the cavity of the chest (Fig. 108); expiration is effected by lowering the

FIG. 108.—First movement : inspiration.

arms and making strong pressure on the front and sides of the bony thorax (Fig. 109). This is best done by two men working together,

FIG. 109.—Second movement : expiration.

one raising and lowering the arms, while the assistant makes strong pressure on the chest (Fig. 110).

In every case the nose, mouth, and throat must be clear of mucus or blood; the tongue should be pulled well forward, and any obstruction to the free passage of air through the fauces and larynx removed.

The application of these fixed principles in cases of asphyxia in anesthesia or in drowning varies but little. In the resuscitation of the apparently drowned the best rules to follow are those formulated by the Humane Society of Massachusetts:

Rule 1.—Unless in extreme cold weather, when there may be danger of freezing, do not move the patient, but instantly expose the face to

FIG. 110.—Expiration: assistant exerting pressure on the chest.

a current of cold air, wipe dry the mouth and nostrils, rip the clothing so as to expose the chest and waist, and give two or three quick, smarting slaps on the stomach and chest with the open hand. If the patient does not revive, proceed at once as follows:

FIG. 111.—Expressing water from the stomach and lungs.

Rule 2.—*To draw off the water from the stomach and lungs:* Turn the patient on his face, place a large roll of clothing beneath the stomach, and press heavily on the back and spine over it for half a minute, or so long as fluids flow freely from the mouth (Fig. 111).

Rule 3.—To produce respiration : If no assistance is at hand and you must work alone, place the patient on his back with the shoulders slightly raised on a folded article of clothing. Draw forward the tongue and keep it projecting beyond the lips. If the lower jaw be raised, the teeth may be made to hold the tongue in place; it may be necessary to retain the tongue by tying a handkerchief under the chin and over the head.

Grasp the arms just below the elbows, and draw them steadily upward until they nearly meet above the head (this enlarges the capacity of the chest and induces inspiration) (Fig. 108).

Next, lower the arms to the side and press firmly downward and inward and backward on the sides and front of the chest, over the lower ribs and the sternum (this produces expiration) (Fig. 109).

Repeat these measures deliberately and perseveringly twelve to fifteen times in every minute. Occasionally rub the limbs upward from the extremities toward the heart, and dash cold water in the face.

Rule 4.—If an assistant is at hand and two can work together, have one kneel at the patient's head, and one astride the hips of the patient, facing the patient's face.

Proceed as directed above, save that when the operator at the head lowers the arms to the sides the second operator presses on the sides and front of the chest backward and downward, throwing all his weight into the movement (Fig. 110).

The method followed by two workers is the same as that by one, save that the second operator applies the pressure on the chest, and while the arms are being raised applies friction and warmth to the body.

Rule 5.—Send for medical aid, stimulants, and warm blankets and clothes as soon as possible.

Rule 6.—Keep up the efforts for fully two hours, or until the patient breathes.

Rule 7.—Practise drying and rubbing from the beginning, in so far as possible, without interfering with the movements of artificial respiration.

Rule 8.—After-treatment.—As soon as the breathing is established, let the patient be stripped of all wet clothing, wrapped in blankets only, put to bed comfortably warm, but with a free circulation of fresh air, and left to perfect rest. Internally give a little brandy or hot water or other stimulant at hand every ten or fifteen minutes for the first hour, and as often afterward as necessary.

In **asphyxia during ether- or chloroform-anesthesia** the head and shoulders of the patient should be lowered either by elevating the foot of the table or by raising the lower extremities of the patient. By so doing cerebral anemia may be prevented. When plenty of assistants are at hand, two men should keep up the movements of artificial respiration as outlined above, while others maintain the position of the patient on the table and attend to the use of stimulants, oxygen, etc. Should the surgeon be alone, he should begin artificial respiration at once and continue it, merely letting the patient's head hang back over a pillow or a roll of clothing, or over the edge of the table or bed. Whenever possible, friction of the limbs and body toward

the heart, the hypodermic use of strychnin and brandy, the administration of oxygen and electricity, and the application of external heat

FIG. 112.—Asphyxia during anesthesia : lowering patient's head.

should be followed simultaneously with the forced respiratory movements.   These measures, however, as well as Laborde's rhythmic

FIG. 113.—Asphyxia during anesthesia : practising artificial respiration.

traction on the tongue, are only auxiliaries, and must never be tried if they involve the abandoning of the movements of artificial respiration (Figs. 112, 113).

CHAPTER VII.

SURGERY OF THE BREAST.

Development.—The first change that we notice in the human embryo is a thickening of the epidermis at about the end of the second month. It is at first very slight, and begins, according to Minot, where the epidermis is two layered, and solely at the expense of the inner layer. Later there is an ingrowth of these cells into the derma, of a flask or pear-shape.

"The epithelial ingrowth enlarges, and the cells in its central position gradually cornify and fall out, so that the ingrowth becomes hollow; but the excavation progresses very slowly, and sometimes is not completed until after birth. Soon after the hollowing has begun the ingrowth sends out buds, which resemble in their appearance and early development true sweat-glands" (Minot). This view is held by Gegenbauer, although many writers assume that the milk-gland is developed from the sebaceous gland.

Contemporaneously with this hollowing there is a depression at the seat of the nipple, which subsequently becomes obliterated by the formation of the nipple. This depression is persistent in the Echidna, forming a mammary pouch; and such a condition sometimes persists to a certain extent in the human subject, giving rise to the "depressed nipple." The branching of the buds which form the glandular tissue begins about the seventh month. The lumen of the glands appears first at their lower ends, which are enlarged and club-shaped, and extends toward the mouth of the glands.

In the embryo of the pig, according to Schultze, the first trace of the mammæ may be observed at about the end of the first month (embryos of 15 mm.) as a continuous ridge-like thickening running from the fore-limb to the inguinal fold. At a later period the ridge is thickened at several points by a growth of this layer of the ectoderm in the pig at 5 to 7 points,

FIG. 114.—Milk-line in embryo of pig, showing development of nipples.

while the intervening portions of the ridge gradually disappear, and in this way by a process of differentiation a series of mammary glands are formed (Fig. 114). These so-called milk-lines are widely separated in early fetal life; but as the fetus develops they approach somewhat toward the median line. They mark the tract along which the milk-glands are formed. It is interesting to observe that it is along this line that the supernumerary nipples and breasts are formed in cases of polymastia in the human subject.

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At the time of birth the gland consists of a series of radiating ducts with club-shaped extremities (Fig. 115). The lumen is now quite marked. There is considerable dilatation, so much, in fact, as to constitute a condition of ectasia. This appears to be due to the activity of the epithelium, which is in a state of proliferation.

FIG. 115.—Mammary gland of new-born infant (Billroth).

Numerous layers of epithelial cells mingled with round cells are found lining the walls of the tubes, and granular and degenerated cell-structures are found in their interior. At the end of the first year of life these tubes form a cavernous structure lined with a pavement epithelium. These changes give rise to symptoms akin to the condition known as mastitis, and account for the swelling and tenderness of the breasts frequently observed in the infant (Kölliker).

No material change in the appearance of the gland occurs until the age of puberty. A few lobular growths only of gland-structures take place during the interval. We now find, in addition to the formation of ducts, a development of acini. An enlargement of the breast with the development of considerable tenderness is often noticed in males as well as in females at this period. The connective tissue which sur-

FIG. 116.—Breast at puberty, showing hyaline tissue around tubes (Billroth).

FIG. 117.—Fully-developed breast-acini at pregnancy (Billroth).

rounds the gland-tubes also undergoes a marked change. It now assumes a peculiar hyaline condition, and is rich in nuclei (Fig. 116). This tissue is in strong contrast with the interstitial tissue lying between the lobes of the gland.

This tissue is of special importance not only in relation to the subsequent vascular formation at the time of pregnancy, but also as the point of departure of certain types of morbid growths. The acini develop by the sprouting of solid buds of epithelium, while the tough

connective tissue and vessels form around them and give to the virgin breast its character-istic firm and elastic consistence (Billroth).

At the time of pregnancy the acini develop enormously and the surrounding tissue becomes much more vascular (Fig. 117). The nipple is perforated by 12 to 15 ducts.

The small nodules which surround the nipple, and which with the areola are pigmented at this time, are small acinous glands, known as Montgomery's glands, and are shown by Rein to be accessory milk-glands. The so-called sinus lacteus is a dilatation of the duct which is found just above the narrow portion which perforates the nipple. This is best developed during the period of lactation. The formation of the milk is due to an emulsion of effused serum and fat which is formed by a change in the epithelial cells.

After the cessation of lactation the acini collapse, but the connective tissue does not contract, and the breast does not return to the rigid condition of virginity, but remains pendulous.

After the period of full maturity has passed we come to the period of decline, which becomes more marked at the menopause. At this period the glandular tissue atrophies. The epithelium disappears, and the acini collapse permanently. The ducts remain as elongated tubes at the end of which can be seen the atrophied remains of the previously existing acini of the gland (Fig. 118). As the glandular structures disappear they are replaced by adipose tissue. At the period of complete senile involution the breast contains little trace of gland-tissue, being composed wholly of elongated tubes and adipose and connective tissue. The larger ducts often undergo a cystic dilatation with the formation of a greenish fluid or mucous secretion, the color being due probably to the staining by fragments of broken-down blood-corpuscles.

FIG. 118.—Atrophied gland-structure of declining breast (Billroth).

Anatomy.—The mammary glands are racemose glandular structures, and are situated beneath the skin on either side of the sternum. The area covered by the gland extends from the third to the sixth rib in a vertical direction in the female, and laterally from the axillary margin of the pectoralis major muscle to a point a little beyond the outer border of the sternum. The gland is usually regarded by the surgeon as a more or less hemispherical organ, somewhat flattened, with a well-defined circular border. The conformation of the glandular structure constitutes a material departure from this conventional type. The various lobules of the gland project along lines radiating from the nipple, and extend to unequal distances. At particular points the prolongations are much more marked than at others, and this is the case at the margin of the axilla, where the gland-structure often extends into the axilla. A second portion projects over the serratus magnus

muscle, and the third principal prolongation is found at the sternal border. When these are well marked the breast assumes a more or less pronounced tricuspid form.

In addition to these projections numerous smaller prolongations often exist. Glandular processes are found between the skin and the gland proper, and numerous isolated masses of gland-tissue are often observed constituting paramammary glands. These result necessarily not only from the peculiar conformation of the gland-tissue, but also from the frequent development of supernumerary glands along the so-called "milk-line."

The nipple is not situated at the center of the breast, but slightly above this point and somewhat nearer the median line. The breast is slightly concave posteriorly, and rests upon the fascia of the pectoralis major muscle and the fascia covering the serratus magnus. With these fasciæ it is somewhat intimately connected, a point of considerable importance in estimating the extent of morbid processes emanating from the gland. The parenchyma of the gland is supported by a dense stroma, which is attached to or continuous with the anterior layer of the superficial pectoral fascia. This fascia is continuous with the superficial fasciæ of the neck. Opposite the mamma it subdivides into two layers, one passing in front and one behind the gland. From the anterior layer numerous processes pass forward to the center and backward into the mammary gland. The forward prolongations of this fascia are known as the *suspensory ligaments* of Sir Astley Cooper. They are exaggerations of the *cones fibreux* of Velpeau, described by the writer in connection with the columnæ adiposæ of the thick skin of the back, where they are also well marked. The drawings of Sir Astley Cooper represent, however, a much more exaggerated development of fibrous bands than is usually seen in sections of the mamma. These "ligaments" possess an importance from a diagnostic standpoint, as they are frequently intimately associated with paramammary glands and lymphatic vessels, and are consequently often involved in the cicatricial contraction which accompanies the growth of cancer. It is to the shortening of these bands that the depression or dimpling of the skin is due in malignant disease of the breast, which dimpling constitutes one of the earliest symptoms of cancer.

The posterior layer of the pectoral fascia rests upon the deep fascia, but is easily removed from it. There is always a loose layer of connective tissue between these fasciæ, and not infrequently a bursa exists there. The deep fasciæ send numerous prolongations between the fasciculi of the pectoralis major muscle. It is needless to say that in operations upon the breast all of the anatomical peculiarities which have been pointed out above should be taken into consideration. They constitute what with propriety might be called the danger-zone of cancer.

For convenience of description the breast may be divided into various regions. A circle drawn around the areola of the nipple indicates the central region. A transverse line drawn through the nipple divides the breast into an upper and a lower hemisphere. A vertical line drawn through the nipples separates the inner from the outer hemisphere. These two lines divide the breast into four quadrants (Fig. 119).

Lymphatics.—A knowledge of the lymphatics of the breast is of the highest importance to the surgeon. The breast in the female is

richer in lymphatics than any other gland (Williams), but in the male they are but little more developed than in the surrounding integument.

FIG. 119.—Showing the quadrants and the "milk-line," or position of supernumerary nipples.

There are two principal groups of lymphatics passing from the gland to the central organs ; those which arise in the more superficial regions of the gland and make their way

FIG. 120.—Lymphatics of the breast (Sappey).

to the axilla, and those which arise from the deeper and inward portions of the gland and can be traced between the ribs into the anterior mediastinum. The bulk of lymphatic

vessels lie superficially, and take their origin largely from the central region of the breast. These form rich anastomoses, which finally reach the surface in four places. Two of these trunks are given off from the outer and upper quadrant, and two from the inner and lower quadrant (Fig. 120). These unite with other subsidiary vessels to form two larger trunks running to the axilla, thus occupying the greater portion of the outer hemisphere and the inner and lower quadrant. This plexus is intimately connected with the superjacent skin, receiving numerous branches from that structure through the fibrous ligaments, and thus anastomosing freely with the cutaneous coverings of those regions. A third group of lymphatics leave the inner margin of the breast and pass between the ribs to communicate with the mediastinal glands.

The deeply seated lymphatics of the gland anastomose freely with those received from the deep pectoral fascia, and unite to form another trunk running to the axilla. The lymphatics of the pectoral fascia do not communicate freely with the muscle. The direction of the lymphatic current is from the muscle to the fascia, and not in the reverse direction. Other vessels find their way between the ribs and the intercostal and subpleural regions and the anterior mediastinum. These vessels originate principally in the inner hemisphere and the inner portion of the pectoral muscle, and penetrate in larger numbers the second and fourth intercostal spaces. Seen from within the thorax, a chain of lymphatic glands accompanies the internal mammary artery, which receives vessels from the intercostal spaces. This chain anastomoses with a plexus of lymphatic glands and vessels distributed over the diaphragm below and above with the right and left lymphatic ducts (Fig. 121). Another set of deep lymphatics originates in the posterior portions of the outer hemisphere and penetrates the intercostal spaces. Here, following the inferior margins of the ribs, they accompany the intercostal vessels and empty into the thoracic duct. In view of the exceedingly rich anastomosis of the lymphatic vessels of the breast, it is easy to understand how readily the integuments of the breast may become involved in a malignant growth originating in that gland, for the growth may so alter the conditions of the lymph-circulation that the diseased organisms may spread in any direction through the lymph-channels. The skin and subcutaneous tissue therefore become one of the most

FIG. 121.—Lymphatic glands of the mediastinum (Sappey).

suspicious regions of the danger-zone, and for the same reason the sub-jacent muscles may readily become infected.

The glands of the axilla receive the greater number of the lymphatic vessels of the breast. They are clustered together in three principal groups: the pectoral, the subscapular, and the axillary (Gerrish).

The pectoral glands lie just beneath the outer margin of the pectoralis major muscle, and receive the large lymphatic trunks above described. This group is the one usually first infected in cancer of the breast, the nodule thus formed being felt beneath the axillary margin of the pectoral muscle. From this group of glands the lymphatics next proceed to the axillary group found in the loose adipose tissue of the axilla and lying on the anterior surface of the axillary vein, forming a network upon its surface. They are readily felt after cutting through the axillary fascia, which covers the large vessels. This group also receives vessels coming from the subscapular group, a group not in direct communication with the mammary gland, but receiving lymphatics principally from the back of the neck and shoulder. It is found at the posterior aspect of the axilla, lying between the scapula and the thorax wall. The glands of this group are not infrequently infected in malignant disease of the breast, owing to their rich anastomosis. From the axillary group the lymphatic vessels accompany the axillary vein, lying principally upon its inner aspect, and finally form one or more ducts, which pass between the clavicle and first rib to enter the right lymphatic duct. It is along this route, therefore, that a careful search must be made for infected glands in operations for cancer of the breast. Finally, these vessels anastomose with the subclavian and deep cervical glands in the posterior cervical triangle, which are also not infrequently infected.

Arteries.—The arteries which supply the gland are small and numerous. They are derived principally from the axillary artery and the internal mammary artery.

The branches of the thoracico-acromial artery supply the upper lobes. The outer lobes are supplied by the long thoracic and the external mammary arteries. The internal mammary supplies the inner lobes through the anterior cutaneous branches of the second, third, and fourth perforating branches of that artery. The second intercostal branch of this vessel is the most important, and divides into a superior and an inferior division, both of which supply the upper hemisphere. The posterior surface of the gland is supplied by the intercostal arteries.

Nerves.—The nerves of the mamma are chiefly derived from the anterior and lateral cutaneous branches of the intercostal nerves. The superficial fascia along the border of the sternum is pierced by the anterior cutaneous branches of the intercostal nerves, which emerge into the arterial branches above mentioned. The nerves for the skin are derived from the supraclavicular and external branches of the intercostals as well as from branches of the brachial plexus.

The posterior lateral branch of the second intercostal nerve is known as the intercosto-humeral nerve. This nerve also receives a branch from the third intercostal nerve. It passes across the upper part of the axilla, issuing from the second intercostal space, and supplies the skin of the inside of the arm as low as the internal condyle. The anatomical arrangement of this nerve-anastomosis serves to explain the sympathy of the arm with painful affections of the breast, and also the neuralgias of the inside and back of the arm which follow operations upon the breast.

The arteries and nerves of the axilla become important in relation to operations upon the breast. In dissection of the axilla the operator usually divides the long thoracic artery at the margin of the pectoralis major muscle, the acromiothoracic when dividing the pectoralis major muscle, and the subscapular artery when dissecting out the contents of the axilla.

The nerves found in this region are the long thoracic or external

respiratory nerve of Bell, the intercostohumeral, and the three sub-scapular nerves.   The middle subscapular nerve, or the largest of them, accompanies the subscapular artery and supplies the latissimus dorsi muscle. The anterior thoracic nerves are two in number.   They arise from the outer border of the brachial plexus, and supply the pectoralis major and minor. Nearly all these nerves may be divided in the operation for cancer of the breast without impairing the power of raising the arm from the body.

A study of the development of the mammary gland serves to throw light upon its various malformations, and furnishes a basis for the classi-fication of the benign tumors of the gland.

As has been shown, there is a pro-liferation of cells in the ducts at the time of birth, which sometimes gives rise to symptoms akin to inflammation. This shows a temporary increased activity in the gland-structures at this period.   In rare instances there is a precocious manifestation of this condi-tion in infancy, giving rise to the condi-tion known as **infantile hypertrophy.** This malformation may either be con-genital or may first manifest itself in early infancy.   It is an exaggeration, as it were, of the condition which in the tropics approaches the normal state, for instances in which children attain puberty at an early age, often at eight years, are more nearly the rule than

FIG. 122.—Infantile hypertrophy of the breast (Marcy).

the exception.   This malformation is usually accompanied by preco-cious sexual development.

A marked example of this condition is a case reported by Marcy.[1]   The patient, at the time the photograph (Fig. 122) was taken, was two years and seven months old.   The pubic hair began to grow when she was nine months old ; at the first month the mammary gland began to develop.   Her mental development at the time of this report was wonderful. The vagina measured fully 3 inches in depth ; it was large enough to receive the right index finger without the slightest pain.   The uterus was considerably larger than in its ordinary undeveloped state.   There had been no menstruation.

Amazia signifies complete absence of the organ.   According to Williams,[2] this is a very rare affection.   It is due to a lack of develop-ment in early embryonic life.   Usually one breast only is absent. Absence of both mammæ is among the rarest of anomalies.   There is an occasional deficiency of the pectoral muscles, and even of portions

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[1] *Trans. Amer. Med. Assoc.*, vol. xxvii., p. 237.   [2] *Diseases of the Breast,* 1894.

of the ribs. The ovary on the corresponding side is also occasionally absent.

Micromazia is more frequent than amazia. The term indicates an incomplete development of the gland. The deformity occurs independently, or is associated with malformations of the adjacent chest or of the sexual organs (Williams). Still more common is **Athelia,** or congenital absence of the nipples. When the nipple is deficient the areola is often imperfectly formed or absent. Malformed nipples are a frequent source of inflammation during lactation.

Polymastia.—Supernumerary glands not infrequently occur. As a rule they are formed on the so-called "milk-line" seen in the embryos of animals. For this reason Orth, Williams, and others have attributed them to atavism. According to this theory, it is supposed that seven pairs of mammæ originally existed on the ventral aspect of the trunk, three above and three below the present normal pair (Fig. 119). There is usually a certain relation between the number of mammæ and the number of young brought forth at a birth, the former being twice as numerous as the latter. The supernumerary glands are not always in

Fig. 123.—Polymastia.

pairs. They may appear singly, according to Bardeleben. In 150 cases observed in conscripts, they were found 76 times on the left, 44 times on the right, and 31 times on both sides. More than three-fourths of all cases are found in the situation of the fifth pair—*i. e.*, just below and slightly inside of the normal mamma. The deformity is more common in the female than in the male. It is exceedingly rare to find supernumerary glands in any other part of the body. *Mammæ erraticæ* have been seen on the ear, the upper part of the thigh, on the labium, etc. Williams is inclined to regard many so-called warty moles

as examples of this malformation. The fact that supernumerary nipples often have hairs growing upon them seems to give weight to this suggestion. Supernumerary axillary structures may often be mistaken for axillary glands, sebaceous glands, and subcutaneous tumors. Most of these axillary forms are paramammary growths due to the separation of gland-structures of the axillary prolongation of the mammæ. Genuine atavistic axillary mammary glands are, according to Williams, exceedingly rare. Fig. 123 shows a case of polymastia as well as of diffuse hypertrophy, and will be described elsewhere. Here it may be observed that there are supernumerary structures above the mamma and in the axillary region. It might be supposed that these were examples of simple sequestration, but the fact that beneath the left breast there is a supernumerary nipple suggests strongly the supposition that they all may be examples of a reversion of type.

Diffuse Hypertrophy of the Breast.—This is a disease which occurs at or about the time of puberty or in connection with pregnancy in early life. The name given to this affection would seem to imply that there is a simple increased physiological enlargement of the breast. It is possible that such cases do occur when the breasts are sufficiently gigantic in proportions to place them in this class. An analysis of the histological examinations of the reported cases does not, however, bear out this view. Dennis, who recognizes a physiological enlargement of this degree, states that they are very rare.

Symptoms.—The disease begins perhaps as an increase in size of a certain portion of one breast, which then becomes more diffuse; and later the opposite breast is affected. Occasionally, however, there is only unilateral enlargement. The growth is later quite rapid; and after a certain size is reached the breasts do not further enlarge. The growth goes on sometimes for years, but in other cases the limit is reached in a few months. The breasts at first are resilient, but later flaccid. The nipples are not increased in size, but become flattened out. The areola is usually increased greatly in diameter. The skin grows with the breast, and it is generally normal, although at times edematous. The veins are enlarged and prominent, but not varicose. The adjacent axillary glands are not affected. The disease is usually painless, although the patients are disabled by the great bulk of the breasts, which sometimes reach nearly to the knees. They are often unable to walk, and are obliged to have a table on which to support the organs, or to lie in the recumbent posture. Great respiratory disturbance is reported in some cases. Occasionally the enlargement subsides after confinement, to increase again with the succeeding pregnancy. Slight injuries suffice to bring about ulceration and abscesses.

In a case reported by Billroth death occurred from erysipelas originating from an ulceration following an attempt to reduce the growth by bandaging. During pregnancy milk is secreted from the breast, and in the case examined by Billroth the slits in the cystic growth contained milk. This is interesting, as showing the close connection of these ducts with the gland-acini in cystic fibroma. Williams, however, reports cases of pregnancy in which lactation did not occur.

Hypertrophy of the breast is sometimes accompanied by gigantism of the corresponding superior extremity.

Pathology.—An analysis of the microscopic examination in various

cases reported shows that the type of growth is that which one would expect to find at the period of puberty. We find, as shown above (Fig. 116), a peritubular and acinous growth of fibrous tissue containing many nuclei, from which growth the new formations at this period of life are liable to take place. The result of the activity of this tissue is a solid or cystic fibroma (see Fibroma). It is the scale on which the growth occurs and its general diffusion throughout the mammary gland which serve to distinguish it from the fibromata as a class.

FIG. 124.—Diffuse hypertrophy of the breast.

In a case reported by Crofford, the bulk of the growth consisted of fibrous tissue devoid of fat, with glandular structures sparsely embedded in it. In Le Double's case the section showed a markedly lobulated structure. The lobes contained gland-structure filled with cylinder-epithelium. In Porter's case Whitney reports a lobulated structure containing gland-acini and a ducts. He says : " In structure, therefore, the growth is essentially a diffuse intracanalicular fibroma, and is not to be regarded in the sense of a true hypertrophy of the breast." In the case examined by Billroth it is evident that the new formation consisted principally of multiple cystic fibromata. Between these tumors there existed a large amount of fibrous tissue and glandular tissue in the stage of lactation. John C. Warren reports a case in which the tumor consisted principally of adipose tissue.

Course.—The disease does not always appear at puberty, but sometimes at a considerably later period of life. In Boyd's case the disease first appeared at the age of thirty years. In Porter's case the patient

was thirty-four at the time of the beginning of the growth. This case was notable for the great size of the breasts, the larger weighing forty-three pounds after removal, the smaller seventeen pounds. This is surpassed by Durston's case, in which the breasts after removal weighed sixty-four pounds and forty pounds respectively. The total growth in this case occurred in four months. The patient died of infection arising from an ulcerated spot.

Cases are reported in which the growths have diminished after marriage, and the retrogression became still more marked after pregnancy.

In a case reported by the writer[1] the enlargement began during the second pregnancy in a woman twenty-three years of age. The disease first appeared in the right breast, and shortly after in the left breast. Above the breast, in range of the "milk-line," were two supernumerary breasts on either side. There was an attempt at the formation of a nipple on the breast in the right axilla, and an accessory nipple below the left breast (Fig. 124). As pregnancy advanced the breast became soft and fluctuating. After this confinement the child was weaned, and the breast soon diminished in size. During her second pregnancy G. M. Atwood reported that the breasts again increased in size. The mother insisted upon nursing the child, and had about a normal flow of milk. Two months after the child was born the breasts receded to the size they had been before the last pregnancy.

Etiology.—The histological examination seems to explain sufficiently well the cause of these growths, without resorting to the theory of trauma or sexual excesses. There is evidently an exaggeration of the physiological tissue-growth of the period of puberty due to idiosyncrasy, and not to any well-defined cause which the history of the case may bring to light. Barton has collected in all 34 cases of this affection.

Treatment.—In the treatment of these cases it is well to distinguish between those which are complicated by pregnancy and those which occur independently of that condition. In the pregnant woman there is always the chance of a subsequent diminution of the size of the growth. In the virgin or non-pregnant woman amputation appears to be the only satisfactory method of dealing with the disease. In those cases in which compression has been tried ulceration and infection have occurred. With the present antiseptic resources such a treatment might be justifiable in cases of moderate size, but in the large tumors the operation should be advised.

Porter reports 16 cases in which operation was performed. Of these, 9 had both breasts removed. One had one breast removed, the other diminishing in size after the appearance of the catamenia. Six who had unilateral hypertrophy had that breast removed. There was but 1 death. Williams reports 22 operations, with 1 death.

The breast should be transfixed with two large skewers (Porter) or by Wyeth's needles, and a tourniquet of rubber tubing applied before the operation, which then becomes bloodless. An interval of a few weeks should be allowed to pass before operating upon the second breast.

The so-called cases of partial hypertrophy are to be regarded as localized new growths, and should be assigned their appropriate place among the groups of tumors of the gland.

Atrophy of the breast occurs normally in the period of involution. This change may take place at an earlier period of life, and may then be regarded as pathological. It may be due to an early removal of the ovaries. Oöphorectomy performed during the period of full sex-

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[1] *Boston Medical and Surgical Journal*, Aug. 3, 1896.

ual development does not appear to influence the size of the breasts. According to Williams, in Bavaria the mammæ are imperfectly developed owing to the hereditary effect of the habit of weaning which has been prevalent there. Potassium iodid is said to diminish the size of the gland; but Dennis reports a case of the employment of large doses of the drug for many weeks in a young girl without any perceptible effect upon the breasts.

Fibroma.—The nature of these tumors will be better understood if attention is given to their point of origin in the gland-structure. A great deal of confusion exists as to classification of fibromas and adenomas of the mammary gland, and this has given rise to a nomenclature which includes such terms as the "chronic mammary tumor," "fibro-adenomata," "proliferous cysts," "intracanalicular papillary fibromata," etc.

Pathology.—By reference to the description of the development of the gland, it will be seen that the acini and small tubes of the virgin
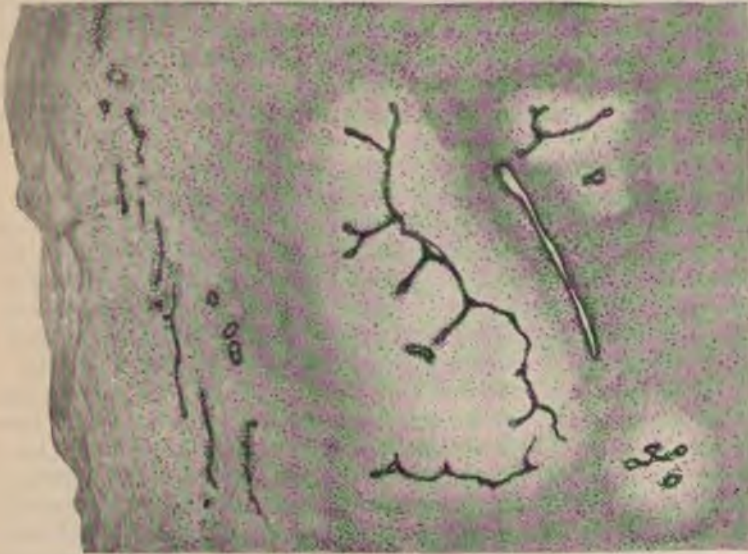
FIG. 125.—Fibroma of the mammary gland.

breast are surrounded by a layer of firm hyaline tissue rich in nuclei, which takes staining differently from the surrounding interstitial tissue (Fig. 125). This is the point of departure, according to Billroth, of all fibromata and sarcomata of the mammary gland. As this tissue grows the small ducts become distended and distorted. The acini do not participate in the changes here described, as they are but imperfectly developed or absent at this period of life. These tumors are consequently composed of a fibrous tissue, on the cut surface of which slits are to be found. These slits when examined under a high power are seen to be lined with a cubical or columnar epithelium. These cells may be attached to the wall in several layers. Usually they are broken down

and are more or less ill-defined, the interior of the slit being filled with degenerated cells, granular débris, and a little transparent fluid.

With the same power the intervening tissue is seen to be composed of fibers more or less densely packed together or of wavy fibers interspersed with nuclei. Variations in this respect occur in different tumors, and give them a correspondingly firm or soft consistence. Immediately around the slits we find a more hyaline tissue (Fig. 125), which reacts differently to the staining-fluids, the two structures being intimately associated with one another. To the naked eye the walls of these slits seem to be a part of the tumor, just as in the case of the lymph-spaces in many fibrous tumors. It is evident that these slits correspond with the smaller ducts of the mammary gland.

Owing to the fact that they become so much elongated and distorted and apparently increased in number in large tumors, some authors (Schimmelbusch) have taken the ground that we have here not only a fibrous but a glandular new formation. Hence the term *fibro-adenoma*, which is adopted by most recent writers. Studying the question from the point of view of development, it would seem more logical to apply, with Gross, the simple term fibroma to these growths, for the essential element is the fibrous tissue, and the glandular structures of the breast at the period of life in which these tumors grow are still in abeyance.

Occasionally these characteristic slits are not seen. This is the case in quite small, hard nodular tumors, and Gross has accordingly recognized two varieties, the solid and the cystic fibroma.

The **solid fibroma** is found at a rather earlier period of life than the cystic form. About one-fourth of them, according to Gross, are seen before the sixteenth year, the average age being about eighteen years. It appears as a small, well-defined round or oval nodule, usually at some portion of the periphery of the breast, and rather more frequently in the upper than in the lower hemisphere. They are usually about the size of a walnut when first brought to the attention of the surgeon, and rarely increase in size—at least, very slowly. They are usually solitary. In a case seen recently by the writer the tumor had existed over twenty years, was about the size of a pigeon's egg, and had given no trouble whatever. These little tumors are usually painless, although during the menstrual period they become somewhat tender to the touch. When removed they are found to be enclosed in a capsule, which enables them to be easily removed by the knife. The cut surface shows a dense fibrous tissue: there is an absence of the characteristic slits of the cystic form. Under the microscope there can be seen a few small ducts and acini. The appearance of the sections is that of a chronic lobular mastitis; but this is hardly the view to be taken of these tumors, for they appear clinically as new-formations, and not as inflammatory processes.

Treatment.—The question of removal should be decided by the clinical history of the case. If the tumor is painful and causes mental anxiety, there is sufficient reason for advising operation. If, on the other hand, the tumor has remained stationary for a long period and causes no inconvenience, it can be left alone. A scar in a more or less conspicuous region is thus avoided. The writer has followed this course with satisfactory results in several cases. There is, however, the possibility

of such a tumor being the starting-point of cancer. The writer has seen one such case. A woman about fifty years of age had a small nodule in the outer hemisphere for thirty years, which had begun to grow a few months before. The growth had already involved the skin. It is possible that tumors in the outer hemisphere show a greater tendency to become the seat of cancer than those situated in portions of the gland which are less likely to be the point of departure of that disease.

The term **cystic fibroma** is perhaps not the best suited to the other form of fibroma (fibro-adenomata, etc.), but it is retained for the sake of emphasizing the histogenesis of the growth. There are no cysts, in the true sense, in these tumors. What we find are merely the somewhat altered and elongated terminal ducts of the gland. The growth has so distorted them that they branch in various directions. The peritubular and acinous tissue grows with such activity and so unequally in its different parts that the slits appear as cavities filled with polypoid growths. Occasionally this tendency becomes so marked that the connective tissue develops a series of papillary growths projecting into one of these closed cavities. Hence the terms proliferous cyst and intracanalicular papillary fibroma, terms which serve to describe the coarse appearances, but which are more or less confusing from the point of view of classification (Fig. 126). This tendency to

FIG. 126.—Cystic fibroma of the breast.

vegetation shows merely a greater activity of the peritubular glandtissue, and these tumors are found, as one would naturally expect, at a more active period of gland-life. They are, in fact, never seen before the sixteenth year, and the average age is probably about twenty years. Those seen by the writer were in young women about twenty years of age. They are situated in any part of the breast, and usually attain the size of a hen's egg or somewhat larger object. They are usually single ; occasionally both breasts may be affected. In a case seen by the writer a tumor was removed from the right breast, and three years later a similar growth appeared in the left breast. Clinically they appear as nodulated, well-defined tumors, lying subcutaneously and lifting the integuments above their normal level. The skin may become adherent to the tumor, and even ulcerate, and it may thus come to pass that some of the papillomatous structure may protrude through the wound. Such tumors have been described as producing even absorption of the rib, but such growths undoubtedly should be classified with the sarcomata.

The cystic fibromata enlarge at first somewhat rapidly, but after they have attained their growth remain stationary. After a certain period of quiescence, if active growth again commences, it is probable that the disease is sarcoma. They may, however, grow rapidly during pregnancy, but cease growing after confinement. The nipple is not affected, nor are the axillary lymphatic glands. There is no discharge from the nipple. Recurrence is said to take place, but this so-called recurrence is due either to the fact that a portion of the growth has been allowed to remain, or, what is more probable, that the case is one of multiple tumors. These tumors are circumscribed, having a well-defined capsule. They do not, however, shell out easily from the mammary gland, but the surrounding gland-tissue is freely incised during the operation.

Treatment.—These tumors may be allowed to remain when the patient is strongly averse to an operation, and the writer has observed

FIG. 127.—Fibroma of the breast.

one or two cases in which for several years there has been no change in the tumor, and the patient has experienced no inconvenience from it. Removal is, however, to be advised, as it is always possible that after a period of inactivity the growth may become sarcomatous. Cancer is less likely to develop in these tumors. Many of these tumors may be removed by Thomas's method, the incision being made beneath the breast, so as to conceal the scar (Figs. 127–129).

Adenoma.—At the period of greatest functional activity of the mammary gland the acini become developed in a much larger proportion than the rest of the gland-structures. There is an increase in the number of acini by a process of budding of the epithelium into the surrounding connective-tissue stroma (Fig. 117). This occurs, as has

FIG. 128.—Line of incision for fibroma in outer lower quadrant.

already been shown, at the time the breast is preparing for lactation. At this period in the life-history of the gland tumors of the true gland-

FIG. 129.—Breast after removal of large fibroma (Fig. 127).

tissue are more likely to be found—that is, some time between the stage of full development and the stage of decline. Gross estimates

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the average age of its first appearance at thirty-four years, and Williams at forty-three years.

Pathology.—It is in the acini of the gland that the first changes in the formation of adenoma must be sought; and as in the physiological development of the acini, so in their pathological growth a proliferation of the cells of the acini takes place and new acini are formed; but in this disturbance of the cell-activity many other changes occur. The acini become dilated, the epithelium is heaped up in them and assumes a columnar form. Many of the cells degenerate and are cast off. The intervening walls of the acini become attenuated and in places disappear. Not only are the acini dilated, but they become much elongated, so at times to give the appearance of tubes; but it is highly probable that the gland-ducts do not participate actively in these changes. The stroma of a cluster of acini changed in this way in one of the lobules of the gland becomes largely absorbed, and a cyst is thus produced, from the walls of which arborescent growths of epithelium project. Meanwhile the gland-ducts become obstructed, owing to the changes taking place in the gland-stroma, and cystic dilatation occurs. The activity of the acinous epithelium continues and papillary growths occur on a larger scale, thus producing the characteristic appearances of this form of tumor. This is the most common form of adenoma, and is the variety to which

FIG. 130.—Adenoma of the breast; microscopic section from specimen shown in Plate 1.

the names *Cysto-adenoma* and *Villous papilloma* are commonly given. The cysts thus formed are frequently quite small, but occasionally developed to considerable size (Plate 1), from the wall of which the true tumor-growth may be seen to project. These cysts usually contain a bloody fluid formed by the increased secretion from the gland-cells mingled with blood which has escaped from the highly vascular villous tufts. If the cells undergo extensive fatty degeneration, the contents of the cysts are of a cheesy character. Microscopic sections of the new-gland structure give a very characteristic appearance. There is a very delicate arborescent framework of connective tissue, forming villi or elongated acini covered or lined with several layers of epithelium, portions of which assume a distinctly columnar shape (Fig. 130). This spongy growth is supported by septa which pervade the new tissue and are supplied richly with blood-vessels. It is due to this fact that the tender papillomatous structures bleed easily.

Symptoms.—These tumors are either multiple or single. In a typical case the tumor is observed growing beneath the nipple or

PLATE I.

Adenoma of the breast.

areola, as a well-defined, somewhat lobulated growth, with an outline easily distinguished in the surrounding tissues. It is firm or soft, and fluctuating according to the amount of contained fluid. It grows slowly, and the patient may have discovered it many months or even years before seeking advice, as there is little or no pain. After a certain period of time a discharge occurs from the nipple. If this is bloody fluid, the diagnosis of adenoma or "villous papilloma" can with certainty be made. The glandular portion of these tumors does not attain any great size, but the tumor may become quite prominent, owing to distention of the cyst with fluid. Occasionally these papillomatous growths may be more extensively diffused throughout the gland, the numerous dilated ducts being filled with small red papillary growths. Cases are reported in which the villi have protruded through the dilated ducts at the nipple, and have thus produced an external fungating growth. The skin is usually freely movable over the tumor, but occasionally may become reddened and adherent. It is rare that it breaks down and allows the contents of the cysts to protrude.

This form of adenoma is benign, those cases of return after excision being examples probably of an incomplete removal of the tumor.

Treatment.—In the single form an attempt should be made to preserve the breast; but inasmuch as the cyst-walls are intimately attached to the more or less atrophied surrounding gland-structure, there is usually but little of the gland left after the tumor has been removed. The surgeon can be guided in the choice of operations by estimating the healing powers of the patient. In the multiple form the whole mamma should be excised.

It is probable that any other form of adenoma is extremely rare in the mamma. Solid growths of purely glandular tissue are sometimes found; but these may be, as Williams has pointed out, simple hypertrophies of paramammary glands. The writer removed, many years ago, an encapsuled tumor on the breast of a middle-aged woman. On opening the capsule its contents proved to be a transparent myxomatous tissue, which on microscopic study was found to contain coils of gland-tissue. A myxadenoma of this type is probably exceedingly rare.

Cysts.—Attention has already been called to the changes observed in the breast during its period of involution. At the time of the menopause the acini begin to disappear in large numbers, and this process continues until the parenchyma of the gland has been absorbed, and all that remains of the gland-tissue are the lacteal ducts, at the terminal portions of which traces of shrunken and atrophied acini may be found (Fig. 118). The interstitial tissue contracts during this process, and the tubes are drawn together at some points and pulled apart at others. In fact, a great deal of distortion takes place. Adipose tissue generally forms and takes the place of the atrophying structure, and thus there is no great change in the breast externally.

As a result of these shrinking processes many of the smaller ducts are cut off from the main tubes, and in the breasts of many middle-aged or elderly women large numbers of minute nodules may be felt, which are the obstructed and slightly dilated tubules of the gland. This occurs so frequently as to be regarded as almost a normal condition. Occasion-

ally this cystic degeneration of the breast-gland becomes a prominent feature, and some of the cysts grow to sufficient size to become easily apparent, forming tumors the size of a walnut or even a hen's egg. In addition to these large cysts the breast is studded with innumerable small cysts, which, when the breast is cut open, appear as dark-colored tumors dotted over the dull-white tissue of the atrophied gland (Plate 2). These cysts when opened give vent to a greenish or chocolate-colored fluid of a somewhat mucous character. It is found to contain degenerated cells, broken-down blood-corpuscles, and cholesterin-crystals.

FIG. 131.—Section from a breast in involution-stage, showing cyst-formation.

The small cyst-walls are covered with epithelium (Fig. 131), but the large cysts are without an epithelial lining, the inflammatory tissue of which their walls are composed containing blood-pigment and hematoidin-crystals.

The point of origin and the nature of these cysts are matters of much dispute. According to some writers (Gross, Réclus, Schimmelbusch), the first changes are seen in the acini; but it is more probable that they occur in the smaller tubes (Billroth, Williams), inasmuch as in the declining breast the acini have already largely disappeared. In the small terminal ducts there is at first an accumulation of cells resulting from the changes in the epithelium. They are distended with a polymorphous, atypical epithelium. These cells subsequently break down and are mingled with a secretion from the wall of the cavity. There is also at times a growth of connective tissue, which forms concentric circles around the tubes to such an extent that the cyst may be replaced by a small fibrous node (Réclus). The activity of the epithelial cells has given rise to the view that the disease is an epithelial growth; and it is regarded by some as an adenoma. The growth of connective tissue has, on the other hand, favored the theory of a chronic mastitis with retention-cysts. The latter view is more closely in accord with the pathological changes. It is, however, highly probable that this affection is an aberration of the process of involution, and that the inflammatory changes seen in the connective tissue and epithelium are incidental features. The peculiar color of the fluid contained in the cysts is probably due to thrombosis of the vessels, which have been obliterated by the shrinking process, the coloring-matter being then conveyed to the excreted fluid, or to minute hemorrhages from the cyst-wall.

Diagnosis.—This disease occurs usually in women of forty years of age and upward, and is most frequently seen at the period of the meno-

PLATE 2.

Involution-cyst of the breast.

pause. The cysts are so small at first that for a long time they escape notice; finally one grows large enough to form a perceptible tumor in the breast. A careful examination will then disclose the fact that there are numerous other small nodules, varying in size from a shot to a pea, scattered through the breast, and in many cases the other breast will also be found to be similarly affected. The disease does not always affect both breasts simultaneously, but it is not uncommon to find the cysts appearing a year or two later in the second breast. The cyst

FIG. 132.—Removal of mammary gland for involution-cysts, with inversion of nipple. Reconstruction of breast by buried sutures.

forms a firm nodular, well-defined tumor, and although it contains fluid the walls are so tense that fluctuation can rarely be detected. The diagnosis can therefore not be definitely settled without exploratory puncture.

The presence of multiple cysts, the occasional discharge of a darkish fluid from the nipple, the absence of infection of the axillary glands, and the slow growth of the tumor are points which serve to distinguish it from cancer. It may show itself in almost any region of the breast.

The **prognosis** of this disease is favorable. The cysts after attaining a certain size cease to grow, and there are rarely any serious complications arising from their presence. The remote possibility of cancer developing in the cyst should be kept in mind, although there are no data to justify the assertion that this is likely to occur.

The question of **treatment** of the involution-cyst is not yet fully settled. If the larger cysts only are excised, the smaller cysts are likely to grow later and produce a tumor. Excision of the entire gland, and perhaps of both glands, for a benign disease is a formidable remedy. Réclus has recently advised abstaining from all treatment, keeping the case under observation. In large cysts an exploratory puncture would be advisable, followed, perhaps, by excision of the cyst. This method might be adopted with each cyst which showed a disposition to become large enough to cause pain or other local disturbance.

The writer's present method of operating for involution-cysts is as follows: The Thomas incision having been made, the breast is reflected upward and its posterior aspect carefully inspected. A V-shaped mass, including the cysts, can now be removed, care being taken to make smooth incisions through the gland-tissue. The edges of the V should then be approximated by buried sutures. If the disease is extensive, it may be necessary to remove all or the greater part of the gland-tissue. The adjacent soft parts can then be drawn in by buried sutures, so as to fill out the cavity thus made. Finally the integuments are turned down and stitched into place. In one case the writer has operated on both breasts simultaneously by this method (Fig. 132).

In case of any doubt in the diagnosis, the whole breast should be removed and carefully examined at the time for cancer, so that in case malignant disease is found the surgeon may continue the operation for that disease to completion. Usually, however, a microscopic examination made during the exploratory operation will settle the diagnosis.

Evolution-cysts.—Gross describes single cysts under this name occurring in women whose breasts are still in a state of functional activity ; and Williams describes " Mucoid cysts " in young, adult, and middle-aged women. Single cysts are often found in the breasts of women of middle life, and are undoubtedly retention-cysts. They are said by Gross to arise from the lacteal sinuses. They are, as a rule, situated in the upper hemisphere, and appear as firm, hard, well-defined tumors. On pressure, fluid may sometimes escape from the nipple. They vary in size from a walnut to a hen's egg. They cause a good deal of mental worry on the part of the patient. If punctured with the exploring-punch, they collapse, a brownish-colored fluid escaping. Frequently they do not refill; if, however, the cyst re-forms, it should be excised.

Galactocele, or lacteal cyst, is a tumor containing milk and occurring at the period of lactation. It is due usually to obstruction of one of the milk-sinuses, and may rarely be found outside the duct, owing to rupture of its wall. Galactoceles contain at first pure milk ; but the contents of tumors of long duration vary according to the chemical changes which have occurred meanwhile. They may therefore be found to contain creamy, oily, or curdy matter, and even a substance of butter-like consistence. In the latter case we have a solid tumor.

These tumors may be single or multiple. If single, they are found usually just beneath the nipple, at the seat of one of the lacteal sinuses. Such a tumor appears as a round or ovoid fluctuating swelling situated beneath the areola. This increases gradually during lactation, to diminish after lactation has ceased. It will, however, increase in size with the next pregnancy. Galactoceles sometimes grow to enormous size. Suppuration and ulceration may occur, although this is rare. It is probable that many of the hard nodules felt in the breast of young mothers, and usually regarded as a lobular mastitis, are due to the presence of retained milk. Probably also some of the cases of acute mastitis and abscess arise from the same cause. Ordinarily, however, there are no symptoms of inflammation, as pain or redness.

The cause of these tumors is probably obstruction due to injury of the duct during nursing. Thus, Mason Warren reports a case that was probably originally a galactocele caused by the application of a puppy to the breast. The nipple was bitten off so completely that the milk could not be withdrawn, and a cyst many years afterward was excised from the breast. It may be caused by the obstruction of the duct by a new growth, as cancer. Such a case occurred to the writer. A large fluctuating tumor was found in the breast of a woman forty years of age, at the time of second confinement. It increased at first slowly for two months, and then quite rapidly; it became red and fluctuating, with chills and high temperature. An incision gave vent to curds floating in a large amount of serum, which material was found surrounded by a medullary cancerous growth.

Treatment.—Small galactoceles may sometimes be cured by puncture or pressing out the contents through the nipple. The larger cysts should be watched carefully, and if they give signs of great distention, they should be incised with every possible antiseptic precaution and allowed to heal by second intention. If they are painless and small, operation may be deferred until after lactation has ceased, when, if desirable, they may be excised.

Lymphatic cysts and hydatid cysts are mentioned by writers, but probably are extremely rare.

The above varieties of tumors comprise those which are peculiarly characteristic of the mammary gland and are more or less intimately associated with it.

Other benign tumors may also be found in the breast, but they are all comparatively rare.

Lipoma (Fig. 133) of the breast is an exceedingly rare affection, a somewhat surprising fact when the tendency to the formation of adipose tissue as a paramammary structure, and the increased development of the same tissue in the interstitial tissue during the period of involution of the gland, are taken into account.

Intramammary lipomata are exceedingly rare, according to Williams, 3 cases only being on record. A few cases of large lipomata springing from the fascia of the pectoralis major muscle are recorded. Billroth records an enormous lipoma growing from this region and pushing the flattened gland before it. Astley Cooper mentions a case weighing 14 pounds.

The subcutaneous lipomata are usually moderate in size.

Diffuse lipomata may occur in connection with hypertrophy of the breast. Such a case was that of John C. Warren, the tumor weighing, when removed, 8 pounds. This form of lipoma may also be seen in connection with diffuse lipoma of the neck and abdomen. The

circumscribed forms of lipoma occur in women between twenty and thirty years of age.

Chondroma and **osteoma** are both mentioned as tumors found with extreme rarity in the breasts. Cartilage in great variety is said by Billroth to be found in the mammæ of bitches. This tissue shows

FIG. 133.—Lipoma of the breast.

changes at times tending toward the formation of myxomatous tissue, and at times bone.

Sir Astley Cooper has described a tumor the greater portion of which appeared to be cartilage; and Kolaczek reports a case of large osteochondroma growing from the rib.

Angioma of the mammary gland is occasionally seen.

Mason Warren[1] reports the case of a healthy woman, forty-seven years of age, with a small, hard, painless lump in the right breast near the nipple. After dissecting through the skin and adipose tissue a mass of dilated veins was exposed. "The rest of the tumor was then carefully dissected out and found to be of an erectile character, occupying the entire gland."

Acute mastitis occurs almost invariably at the period of lactation. Although an acute inflammatory process, it is occasionally observed in the breast at the time of birth, and at puberty it is so rare as to deserve

[1] *Surgical Observations.*

no more than a passing mention. Dennis has observed inflammation in the infant follow rough manipulation of the breast on the part of the nurse in attempts to empty the gland of the few drops of colostrum that are sometimes secreted.

The **etiology** of puerperal mastitis has not been fully established. According to Baum, however, the Staphylococcus pyogenes aureus and albus have been found in the milk and also in the gland-tissues. It is probable that these organisms are conveyed into the breast through the openings of the ducts in the nipple. This infection takes place either as the result of inflammatory or eczematous processes on the surface of the nipple, or the organisms may be conveyed from the mouth of the child. During the act of nursing a certain amount of trauma may be inflicted upon the orifices of the ducts which could pave the way for infection. It is even possible that infection may take place through some minute wound in the nipple, and thus an invasion of the tissues through the lymphatics could take place.

After the organisms have gained an entrance their rapid proliferation in the milk in the gland produces a coagulation of the milk. The cells lining the ducts and acini swell and desquamate, and the connective tissue about the acini is soon filled with leukocytes. The inflammation seems to limit itself to the immediate neighborhood of the gland-structure, as sections of an inflamed part show the interstitial connective tissues at first comparatively free from infection. It is probable, therefore, that the virus follows the perilobular lymphatics, and spreads in this way through the very rich lymphatic anastomosis in all directions.

The disease may infect not only the parenchyma of the gland, but also the loose connective tissue behind the breast (*submammary abscess*), and the breast may thus be pushed forward by an extensive collection of pus. Suppuration may also occur beneath the areola as the result of an infection of Montgomery's glands. According to Billroth, acute mastitis is more common in primiparæ, and it is liable to attack the right breast more often than the left. In the beginning only a portion of the breast is affected, and this is said to be most frequently the lower and outer quadrant.

Symptoms.—The disease begins usually during the first four weeks after the birth of the child, and the first symptom is pain in the part affected. Palpation discloses an indurated mass.

The local disturbance is accompanied by a rise of temperature, and a chill often occurs early in the history of the case. On examination the part will be found to be swollen and the skin reddened. Even at this time it is possible, under suitable treatment, that the inflammation may terminate by resolution. If, however, suppuration occurs, fluctuation is soon perceived, and the abscess, if left to itself, will eventually break and discharge its contents. Meanwhile other abscesses are likely to follow in different parts of the gland, and the breast eventually may be riddled with pus.

The **prophylactic treatment** consists in a careful support of the breast by a suitable bandage, and in preserving as nearly as possible an aseptic condition of the nipple. The nipples should be carefully washed and further cleansed by a 2 per cent. boric-acid wash after each nursing. After suppuration has been established an anesthetic should be given, and the abscess-cavity should be freely laid open. Its interior should be carefully disinfected by curetting and washing with hydrogen peroxid,

carbolic acid, or corrosive sublimate, or, if a milder wash is desired, a solution of sulphonaphtol, 1 : 500, may be used to douche the wound. Extreme care should be taken not to lay open the surrounding abscess-wall, and thus expose the lymphatic system to further infection.

After prolonged suppuration fistulæ may remain, and these may open not only externally, but may penetrate between the ribs and communicate with the pleural cavity. These fistulæ generally heal spontaneously after the cessation of lactation. Should one be present, it should be thoroughly laid open, disinfected, and allowed to heal by granulation.

Chronic Mastitis.—Under this name are classified by different writers both suppurative and non-suppurative inflammations of the breast.

The non-suppurative form is the variety usually described by the term Chronic Mastitis. This may be subdivided into two varieties: the diffuse and the circumscribed.

Diffuse mastitis may occur at any period of sexual life, but is commonest after lactation or at the climacteric. It is characterized by an increase of the interstitial connective tissue of the mamma and a gradual destruction of the glandular structure. There is increase in the cells of the connective tissue at first, and subsequently a transformation into dense cicatricial tissue. Meanwhile the epithelium proliferates and subsequently undergoes degenerative changes, and in this way the destruction of the entire gland is effected. The process is evidently an interstitial mastitis, or, as it has been called, a *cirrhosis mammæ.* A cut section of the gland shows a dull opaque white surface, with little characteristic appearance of normal gland-tissue.

Symptoms.—The disease begins with an inflammation in some part of the breast which gradually involves the entire gland. There is general ill-defined pain or tenderness, but no symptoms of acute inflammation. With the shrinking process the nipple may be depressed and the breast lose its prominence.

Such external deformity as that described by Billroth is strongly suggestive of the atrophying form of scirrhous cancer, an affection for which this disease is likely to be mistaken. The differential diagnosis is undoubtedly difficult, and rests upon the history of the case and the presence or absence of enlarged glands in the axilla.

A case of chronic mastitis in a single woman about thirty years of age was sent many years ago to the hospital for amputation of the breast, on the supposition that it was a case of carcinoma. A histological examination showed the presence of a large amount of connective-tissue growth, and gland-structure much disturbed and altered. There was no evidence of cancer. A year or two later the patient applied to the writer to have the other breast removed. This request being refused she had it removed by caustic. This patient was seen many years after in perfect health.

Circumscribed or Lobular Mastitis.—This is an inflammation of one of the lobes of the gland, and may show itself either as a small induration which affects some adjacent portions of the glands, matting them together into one mass, or as a series of small indurations which involve the separate lobules.

Symptoms.—Small indurations in the breast may be seen at any time of life after maturity. In young married women such indurations may be found after pregnancy. They cause some pain and alarm. After remaining for a few months they usually disappear. It is possible that

such a lump may at times form round a minute galactocele, or that a retention-cyst may be the center of such a focus. The disease is seen in single as well as in married women, but less often, and in such cases is probably due to some local trauma. The lump is hard and ill-defined, but may be distinguished from a carcinoma by its more nodular contour, showing that traces of the gland-structure still remain.

It is usually more tender than a malignant growth. This circumscribed form of mastitis is not to be mistaken for the small solid fibroma which is seen soon after puberty and is sometimes described as a lobular mastitis.

Lobular mastitis is an affection seen usually in middle-aged women, both single and married. It is characterized by the formation of a number of small indurated clusters of acini which, when felt near the axillary border, resemble a chain of enlarged glands. They are often exceedingly tender. The affected breast seems somewhat enlarged and feels heavier than the other breast. Coming as it does near the

FIG. 134.—Supporting bandage of breast, front and back views.

period of involution, it is possible that a chronic inflammation may be set up by some obstruction of the duct. The dragging of a pendulous breast seems at times an exciting cause; and it is possible that the pressure of the corset or of a musical instrument, or unusual exercise of the arm on the side affected, may produce such symptoms. This form of mastitis is often accompanied by neuralgia, and the symptoms are all accentuated at the catamenial period. This form often persists for years without involving any special complication. In many cases the symptoms will subside entirely to reappear in a few months or a year.

Treatment of Chronic Mastitis.—The principal rôle which the surgeon plays in this disease is that of diagnostician. The great ques-

carbolic acid, or corrosive sublimate, or, if a milder wash is desired, a solution of sulphonaphtol, 1 : 500, may be used to douche the wound. Extreme care should be taken not to lay open the surrounding abscess-wall, and thus expose the lymphatic system to further infection.

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FIG. 134.—Supporting bandage of breast, front and back views.

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Treatment of Chronic Mastitis.—The principal rôle which the surgeon plays in this disease is that of diagnostician. The great ques-

tion to decide is the question of cancer. The disease itself, in either the diffuse or the circumscribed form, is but slightly susceptible to treatment. Frequently the patient is usually satisfied with a favorable diagnosis. The habits of life should be carefully investigated and the patient advised to avoid any custom which tends to produce irritation of the gland, such as pressure from clothing or fatigue from overuse of the muscles of the corresponding arm. Support by a suitable bandage (Figs. 134, 135) or apparatus produces relief to pain and favors the resolution of the inflammation. Local applications are, as a rule, to be avoided, as they involve cumbersome bandaging and are difficult to apply without producing irritation. The effect of iodin or ointments upon local indurations is, moreover, somewhat problematical, and it is always possible that such applications may cause undue irritation.

FIG. 135.—Lighter form of supporting bandage, applied as in Fig. 134.

Chronic Suppurative Inflammation.—Abscesses of the breast occurring without the symptoms of acute inflammation may be due to various causes. The etiology of a large number of these abscesses still remains to be determined.

Tuberculous abscesses of the breast have been recognized and described, but there is a group of non-tuberculous chronic suppurative processes about which but little is as yet known. Réclus reports several cases of abscess which appear to have formed in the gland-ducts several years after lactation as the result of infection of a probable undiscovered galactocele. In one case only, a woman of sixty years, was a bacteriological examination made, a bacillus resembling the Bacillus coli communis being discovered.

The diagnosis in this case was the infection of an old galactocele during an influenza. Williams reports several cases of "cold abscess"

which were not tuberculous, and one supposed to be of galactocele origin. A careful bacteriological study of this class of cases is needed to settle definitely their nature.

Tuberculosis of the mamma is a rare disease ; bacteriological examination will probably show that the majority of cold abscesses are tuberculous.

In 40 cases collected by Mandry there was only 1 case in which the male breast was affected. The ages of the patients varied from seventeen to fifty-seven years. In 17 cases there were enlarged glands in the axilla, and in many cases fistulæ had formed. According to Roux, infection appears to take place through the blood-vessels or the lymphatics, or by the breaking down of foci which have formed in the adjacent rib or sternum. It may also be caused by infection through an abrasion on the nipple or directly through the ducts.

The disease may occur as a disseminated tuberculosis of the breast, which is said to be the most common form. An isolated tuberculosis-nodule may also at times be observed. Cold abscess may occur in a limited number of cases.

Symptoms.—In the diffused form the breast may be enlarged, or it may shrink greatly and the nipple retract. In some cases there are numerous fistulæ. When a tuberculous nodule forms, it is usually found in the upper and outer quadrant, and its tuberculous nature may be suspected owing to the presence of enlarged glands in the axilla. In cold abscess the breast is more or less enlarged by a fluctuating tumor coincident with hypertrophied and perhaps suppurating glands in the axilla. The pus which is discharged is flaky and contains a few tubercle bacilli. The lesion is usually painless.

An example of infection through the duct is probably the following case : A tuberculous cavity about the size of an English walnut was found near the nipple in an unmarried woman about twenty years of age ; a microscopic examination showed the presence of tubercle bacilli. It was discharging through a small sinus. The cavity was laid open, curetted, and packed with iodoform gauze. The wound healed without further infection of the gland. In another the disease originated in a carious rib ; a cold abscess formed beneath the gland and burrowed into the mamma in several directions. It was necessary to turn the breast up by a curved incision along its inferior border in order to reach the diseased bone and check the forming of pus in the gland.

A cold abscess was situated in the breast of a girl eighteen years of age, and a bacteriological examination showed the presence of bacilli in the abscess-walls. The abscess was opened and curetted and healed readily under an iodoform dressing. A microscopic examination showed the presence of a large number of tubercles in the diseased tissue. Epithelial and giant cells were found, which appeared to originate in the acini.

Small nodules or abscesses may be treated by incision and curetting. When the breast is extensively affected, it is of little use to treat the various fistulæ which have formed, but amputation in such cases is undoubtedly the wisest course to pursue.

Syphilis of the breast may occur as a primary lesion in the nipple. Such a case is depicted by Dennis. Sometimes it occurs as a fissure and may be overlooked. Mucous patches may also form on the nipple and in the folds of pendulous breasts.

Gummata may develop near the surface, and, breaking down, may form excavated ulcers. Deeper in the gland a nodule may form which will eventually soften and form a cold abscess. It can probably be distinguished from a tuberculous abscess by the absence of a tubercular membrane and by the presence of syphilitic manifestations elsewhere.

There may be a diffused syphilitic infiltration of the gland.

Mastodynia.—An enlargement of the breast with tenderness is

not uncommon at times of uterine disturbance, for the breast is at all times in marked sympathy with the uterus. Such symptoms are observed, therefore, frequently at the time of the catamenia or during pregnancy, or finally at the climacteric.

An exaggeration of this condition constitutes the affection known as mastodynia. It is observed most frequently in early life, when the breast is approaching its period of highest development. The period stated by Gross is from fifteen to thirty years. In a marked form of the disease the breast is exceedingly sensitive; pains are felt running from the periphery toward the center, and often into the shoulder and down the arm as far as the elbow. The affected breast seems slightly larger than the opposite one. In its milder form this causes anxiety for fear that it may be a symptom of malignant disease. An examination of the breast may disclose nothing; but occasionally the gland is more perceptible to the touch than on the other side, and in some cases sensitive nodules may be felt (lobular mastitis). These nodules are occasionally exquisitely sensitive, and the whole gland may be so hyperesthetic as hardly to bear the pressure of the clothing.

The disease occurs in patients who have a tendency to hysteria or in those who are subject to neuralgia or rheumatism. The nerve-supply of the breast, which comes from the intercostal and intercosto-humeral nerves, explains the association of the pain with intercostal neuralgia and the sensitiveness of the inner and posterior aspect of the arm.

A woman twenty-six years of age, well nourished and healthy in appearance, is subject to sideache and rheumatism. She applies for an opinion as to the question of malignant disease of the breast. The left breast is slightly larger than the right breast, and the outline of the gland can be felt more easily. There is little or no pain on pressure. The upper inner quadrant appears to be the principal seat of the pain, which is most marked at the catamenial period. The patient is entirely satisfied with a favorable prognosis and does not ask for treatment.

In some cases the patient is extremely solicitous and demands treatment or an operation. Billroth relates such a case, in which several operations were performed by different surgeons for the removal of small painful nodules.

Treatment.—In large pendulous breasts relief can be afforded by suspensory bandages (Figs. 134, 135). There is no specific course of treatment for this affection, and local applications had, as a rule, better be avoided.

Sarcoma.—This is a comparatively rare disease. It is much less frequent in the breast than in other parts of the body. According to Williams, of 2397 neoplasms in the breast, 1863, or 77.7 per cent., were cancer, and 94, or 3.9 per cent., were sarcoma.

There are two principal varieties of sarcoma of the breast, according to their point of origin, the solid and the cystic sarcomata.

The **cystic sarcoma** grows from the layer of hyaline tissue which surrounds the smaller ducts and acini, and to which reference has already been made in the breast of puberty and in the description of the fibromata. The solid sarcoma grows in the interstitial tissue of the gland and pushes the glandular elements aside.

The cystic sarcoma is by far the most frequent of the sarcomata. Growing as it does from the same structure from which the fibroma develops, it is at first very hard to distinguish it from this tumor. The

cystic sarcoma occurs somewhat later in life than the cystic fibroma. In a series of 35 cases Gross found the average age to be 33.7 years. They form more rapidly and are not quite so well defined and lobulated as the fibromata.

On the cut surface these tumors show the same marked clefts as in fibroma ; but in sarcoma the clefts are larger in size and the connective tissue shows a much more exuberant growth. The appearances thus presented are those of irregular slits and clefts into which polypoid growths project. They seem to crowd into the cysts and bulge up over the surface of the section. These clefts, as has already been shown, are the elongated and distended ducts, and in places one can trace the distended and partially obliterated terminal acini. The epithelium also takes part in the growth, as may be seen from the fact that the cells are heaped up in several rows and sometimes fill the pouches of the cysts. In the greater portion of the surface of the clefts the epithelium is wanting, having been cast off and mixed with mucus, which fills the cavities of the cysts. In rare instances these spaces may be filled with blood ; but, as a rule, they do not contain any large amount of fluid : they are rather empty cavities. The surface is of a fleshy character and varies in consistency. It may be composed of a spindle-cell or a round-cell structure, and the same tumors may vary at different points. In some portions fibrous tissue is found, in others sarcomatous tissue, and in others still myxoma is seen. Cretaceous material and even bony growths are seen in these tumors.

FIG. 136.—Cystic sarcoma of the breast.

These tumors are enveloped in a well-defined capsule, and the surrounding parts appear to be unaffected. The mammary gland together with the nipple is completely involved with the growth. As the tumor grows it gradually becomes an irregular-shaped swelling with numerous protuberances, at first not involving the skin, but later attached to it in places. The skin may become somewhat coarse and discolored, and

enlarged veins are seen. There may be some discharge from the nipple. Finally the tumor becomes enormous in size, but is still kept within its capsule and hangs as a pendulous mass from the chest-wall (Fig. 136). The axillary glands are not enlarged, and the general appearance of the patient is that of one not the subject of the sarcomatous cachexia.

The principal characteristics of the cystic sarcoma are its early resemblance to fibroma, its slow growth, its large proportions, and its well-developed capsule.

Solid Sarcoma.—This form of sarcoma develops from the interstitial connective tissue of the breast, pushing aside the glandular elements and compressing them. Nearly all the ordinary types of sarcoma are found, such as round-cell sarcoma, lymphosarcoma, alveolar sarcoma, giant-cell sarcoma, and, very rarely, melanotic sarcoma. Billroth mentions a case of the latter form, also a round-cell sarcoma in which striated spindle-cells were found. They present no essential peculiarities in the breast that are not found elsewhere. None of them is as common as the cystic sarcoma. The commonest seat of sarcoma is beneath the nipple; but when it develops at the periphery of the organ, it is usually found in the upper and inner quadrant. The central growths are usually cystic. Sarcoma is found usually in early life—of 60 cases collected by Gross, only 13 appeared in patients over forty years of age.

The **prognosis of sarcoma of the breast** is, according to Gross, not so favorable as is generally supposed. He based his estimate upon a study of 156 cases. Although the lymphatic glands of the axilla are rarely affected, metastasis of the internal organs is not uncommon. "A sarcoma occurring in a functionally active breast evinces a marked disposition to recur after operation, with less disposition to metastasis; while sarcoma of the declining breast recurs less frequently, but is generalized in a greater number of instances." It is probable that the bad reputation which Gross gives to cystosarcoma (recurrence in more than one-half the cases) is due to the fact that the more advanced and gigantic types of this form of sarcoma are usually reported. In the earliest stages the tendency to recurrence is undoubtedly much less.

Experience has shown that repeated operations may finally result in a permanent cure. The patient may be considered as safe from a recurrence of the disease if four years have elapsed since the last operation.

Myxoma is said to be the rarest form of connective-tissue neoplasm in the breast. Of 7 examples collected by Gross, 1 was hyaline, 1 hyaline and hemorrhagic, 2 were lipomatous, 2 were telangiectatic and lipomatous, and 1 was fibrous and telangiectatic. Owing to their cellular structure, they occupy an intermediate state between fibroma and sarcoma in point of view of malignity. Gross reports 1 recurrence in 3 cases on which operations were performed. They may develop at almost any period of life. It is probable that several of those described by Gross were found in the cystic form, and that in all probability they originate in the hyaline periacinal and ductal tissue.

The author has seen several cases of cystic sarcoma in which por-

tions of the tumor were distinctly myxomatous, but has never met with an isolated form of myxoma.

Carcinoma.—The breast is one of the most frequent seats of cancer. In a series of 7881 cases of cancer collected by Andrews the disease appeared in the breast 1232 times. Andrews places the breast after the uterus and the stomach in point of frequency. Williams states that 40.3 per cent. of all cancers are in the breast and 34 per cent. are in the uterus. Cancer of the breast is also said to be growing in frequency. Precise data upon this point are wanting. It is probably much more frequent to-day than it was fifty years ago. The disease has in all probability grown out of proportion to the growth of the population. Cancer is, moreover, by far the most common neoplasm of the breast. Eighty per cent. of all tumors of the breast are said to be cancerous. Billroth in a collection of 440 tumors of the breast found 18 per cent. only that were non-malignant. It is a disease particularly rare in the male sex, being seen in only 1 per cent. of the cases. On the other hand, it is much more common in married women than in single women, and according to some authors the disease appears to be most frequently seen in multiparæ. Certain it is that a history of puerperal mastitis is found in about 20 per cent. of all cases; and according to Dennis, mastitis of whatever cause accounts for 30 per cent. of the cases of cancer. This includes inflammation from traumatism, which, according to some writers, has a direct influence upon cancer.

Numerous cases are reported in which the development of cancer occurs immediately after a blow, and evidently in consequence of the injury. Two such cases occur to the writer: one the result of a blow by a base-ball, and the other from a blow caused by falling against a sharp angle of furniture. In both the disease was of the most malignant type. Trauma is said, however, to be observed in only about 13 per cent. of cases.

Racial peculiarities exert a marked influence upon the development of cancer. Carcinoma is said to be about twice as frequent among the foreign-born in the United States as among the native white race. It is rare among negroes: the writer has seen 3 cases. Dennis reports but 2 in his experience. Cancer is said to be much less common in tropical than in temperate countries. It has been shown by Haviland to be most prevalent in damp and in low-lying districts in England. In the United States it is said by Billings to be most prevalent in the New England States and on the Southern Pacific Coast; although it occurs frequently in New York, Pennsylvania, and Ohio, in the interior of Michigan, and in the southern part of Wisconsin. It is least seen in the Mississippi Valley and in the South, and the proportions are generally lower in the coast-region than in the interior.

Heredity is an etiologic factor about which there is much dispute. Gross, tracing the tendency to cancers in the direct line of descent only, finds that it is reported in only 4.72 per cent. of cases. Williams, on the other hand, found a history of cancer in 24.2 per cent. in 138 cases. Rare instances of marked susceptibility to cancer in certain families are reported from time to time (Paget, Broca).

A lady who had been operated upon in 1884 for cancer of the breast, and who has had no return of the disease since, reported that her maternal grandmother died of cancer of both breasts at the age of thirty. A maternal aunt died of cancer of the breast; a cousin on the mother's side died of cancer of the rectum, and an aunt on the father's side had recently been operated upon for cancer of the rectum.

The microbic theory of the origin of cancer has many advocates; but although the researches of Plimmer and others are strongly suggestive of the existence of a protozoön as a cause of cancer, no definite or reliable data have thus far been obtained.

17

The period of life in which cancer of the breast first shows itself is that immediately preceding the menopause. Gross in an analysis of 1622 cases found the average age to be 48.66 years. In 63 cases tabulated by the writer the average age was 49 years. There were 25 between 50 and 60, 9 between 60 and 70, 21 between 40 and 50, 6 between 30 and 40, and 27 between 45 and 55 years of age. But 1 case has been reported by Gross as occurring as early as the age of twenty-one. In the writer's series there was one patient who had first noticed the disease when she was twenty-two years and three months old. It thus appears that cancer is pre-eminently a disease of the declining breast. Cancer is said to occur about as frequently in one breast as in the other. It is, however, much more frequent in the upper than in the lower hemisphere, and more frequent in the outer than in the inner hemisphere. The most frequently attacked region is therefore the upper and outer quadrant, or that part of the breast nearest the axilla. The region of the areola comes next in order. Occasionally cancer may develop quite independently of the mammary gland in an accessory or paramammary gland-structure.

Varieties.—The most rational and convenient method of classifying the different forms of cancer of the breast is that based upon the nature and amount of the cell-elements in the morbid tissue. According to this plan, there are two principal groups, the medullary and the scirrhous carcinomata. To these may be added the rarer forms of the disease, such as colloid cancer and Paget's disease of the nipple; also adenocarcinoma and cancer of the axillary border. That form known by some writers as "duct-cancer" has been placed under adenoma, where it properly belongs.

In the *medullary form* the cells are of a globular type of epithelium; the alveoli are either large or numerous, and may vary according to the shape of the plugs of cells that accumulate in the stroma. These plugs are sometimes round or oval in shape, and at other times are long and narrow. Growths in which one or the other form prevails have been called by Billroth "acinous" or "tubular" cancers. A combination of the two often occurs. It seems as if these shapes were determined by the point of departure of the morbid process from the smaller ducts to the acini. The stroma is composed of connective-tissue fibers in which there is more or less round-cell infiltration. It is sometimes exceedingly small in amount, only a few fibers forming the trabeculæ which separate the different alveoli; and in such cases the cell-masses or plugs are very numerous. The larger the number of cells in the tissue the softer the growth; and the term medullary is therefore a most appropriate one to describe such a condition (Fig. 137).

In the periphery of the tumor the tissue which immediately surrounds the cancerous growth is usually infiltrated extensively with small round cells. The stroma may be very abundant in certain portions of a tumor, and the cut section shows that tissue at this point to be much denser than elsewhere. The general appearance of the surface thus exposed by a sharp knife is that of a fleshy, succulent tissue of a grayish-red color, in which striæ of a lighter color ramify. There is no well-defined border, as the growths infiltrate the surrounding tissue instead of pushing them aside. By scraping lightly with the knife-edge an abundant creamy fluid is obtained, known as cancer-juice, which is composed of clusters of cells floating in serum which have been expressed from their alveoli. As medullary cancer progresses the cell-element predominates more and more; and in the final stages, when the lymphatic glands and capillaries and the viscera are involved,
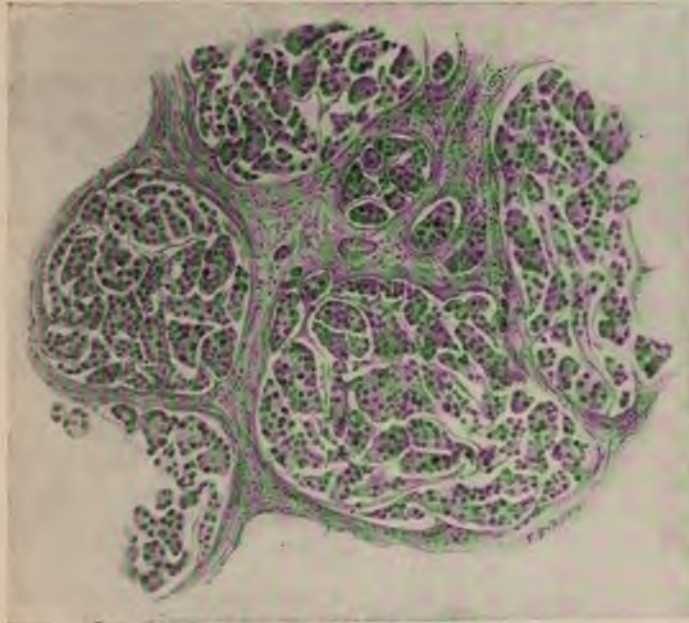
FIG. 137.—Medullary carcinoma.

whole regions become transformed into a soft cellular growth, and the fibrous stroma is represented by a thin reticulum of supporting tissue.
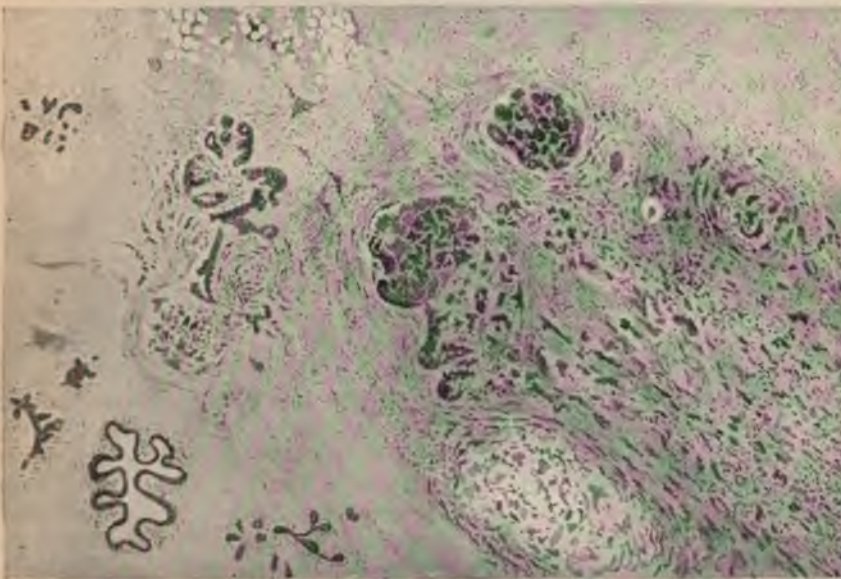
FIG. 138.—Spread of cancer from gland-acini: normal gland-structures on the left; infected gland in the center, whence the disease spreads to the right.

Scirrhous Carcinoma.—In this variety the connective-tissue structures are the predominating feature; the cancer-cells are at times collected in

clusters, and so few in number and small in size are they that they were overlooked by the earlier pathologists. The alveoli are usually found scattered at greater or lesser distances from one another, and are generally ovoid or spindle-shaped. In studying the earliest changes in these growths one sees the smaller clusters of acini filled with cancer-cells : the basement membrane of these acini finally yields, and the cells burst through the gland-walls and infiltrate the surrounding stroma (Fig. 138). Under the microscope numerous alveoli will be found in the neighborhood of such acini, between the meshes of the connective tissue. In the more characteristic parts of the tumors a very dense and cicatricial tissue is found ; broad bands of apparently swollen and fused connective-tissue fibers are formed, with here and there a few cells grouped together in thin and elongated clusters (Fig. 139). In the "atrophying scirrhus," which is the extreme type of this
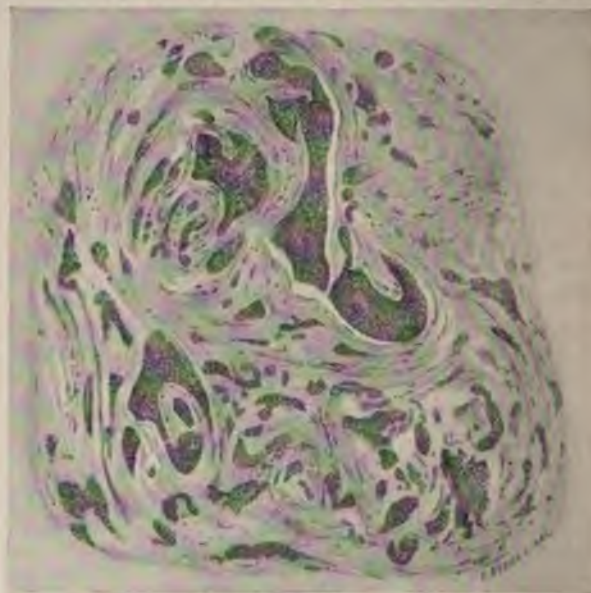
FIG. 139. —Scirrhus.

variety of carcinoma, such tissue prevails. The contracting character of the newly formed tissue seems to check cell-growth and the formation of new vessels. Many of the cells degenerate and calcify, or are absorbed, and this form of scirrhus degenerates *pari passu* with its development, so that the breast seems to wither and atrophy, and at no time is there the appearance of a tumor. A section of such a breast shows the nipple retracted and attached to a band of whitish fibrous tissue, in which remnants of the ducts may be seen. This central mass is continuous with a few cicatricial bands which branch out into the remains of the gland and adipose tissue. It has pre-eminently the appearance of a cicatricial tissue.

Colloid carcinoma is extremely rare. Gross estimates it at 1.34 per cent. of all breast-cancers. The writer remembers having seen but

3 specimens. The appearance of a microscopic section of a typical colloid cancer is very striking. The alveoli are usually round or ovoid, and the trabeculæ of the stroma are extremely thin and transparent.

FIG. 140.—Colloid carcinoma.

The alveoli appear to be over-distended with a gelatinous material, which apparently has been developed at the expense of the contained cells, for the latter are few in number, attached in clusters of two or
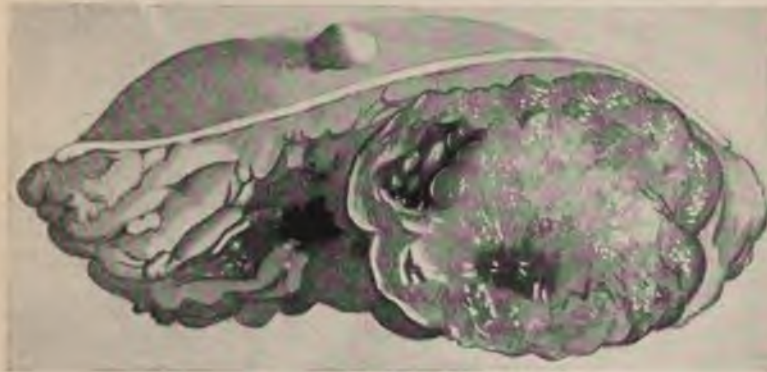
FIG. 141.—Colloid carcinoma.

three to the alveolar wall, or suspended in the material with which the alveolus is filled. The colloid substance is either transparent or homogeneous, or is traversed by numerous fine striæ. In other cases the usual characteristic carcinomatous tissue may predominate, but it will

FIG. 142.—Adenocarcinoma.

be more or less modified by the colloid material which pervades the growth. At times the stroma undergoes colloid degeneration, while the cells remain unaltered (Fig. 140).

FIG. 143.—Paget's disease of the nipple.

A cut section of such a tissue presents a striking appearance, somewhat like that of the cut section of a plum or grape (Fig. 141). The tissue is quite transparent and has a marked gelatinous appearance.

Adenocarcinoma (Fig. 142), or malignant adenoma, is a term employed by Halsted to designate a form of cancer in which there is a tendency to pedunculation of the tumor, which is more or less prominent on the surface. There is also a tendency to softening and breaking down of the somewhat exuberant growth of cancer-tissue. The axillary glands are probably rarely infected. The microscopic examination of these tumors shows large acini containing masses of epithelial cells surrounding a central cavity. These tumors are but mildly malignant. They are not very common.

Paget's Disease of the Nipple.—This affection is an excellent example of that morbid state of the epidermis known as the "precancerous stage" seen also in the "chimney-sweep" and the "paraffin" forms

FIG. 144.—Paget's disease: section of nipple, showing infection of ducts.

of cancer, and in a less degree in keratosis senilis. Limited at first to the areola and nipple, it eventually spreads to the ducts and acini of the glands and runs the course of a mild form of carcinoma (Fig. 143).

The histologic changes observed in this disease have been studied by Paget and Porter, and later by Butlin and Thin. The earliest stage is a keratosis of the epidermic layers of the skin, the cells of the epidermis increasing in numbers and the cells of the rete, particularly those lying between the papillæ, become more abundant. The epidermis is thus thickened and raised in crusts, and the interpapillary epithelium projects more deeply into the

cutis vera. The true skin is much infiltrated with small round cells, and there is an increase of vascularity in the affected part (Fig. 144). At the beginning of the cancerous stage an epithelial growth is found invading the corium and its various glandular structures, such as the sebaceous and sudoriparous glands and the ducts of the mammary gland. The ducts are evidently filled with pavement-epithelium cells. As these cells grow, the walls of the smaller ducts give way and the epithelial growth invades the stroma of the gland.

It still preserves the type of epithelial or epidermoid cancer, and involvement of the lymphatic glands does not take place until late in the disease.

Cancer of the axillary border is a term applied by the writer to a form of carcinoma of this region which begins as a lenticular nodule in the fold of skin marking the pectoral margin of the axilla. It remains for a time confined to the skin, and appears as an infiltration of the cutis vera covering a portion of the surface about the size of a quarter of a dollar. It has usually a depressed center and a rim or border presenting a well-defined outline. Eventually the mammary gland is infected, and the disease spreads thence to the axillary glands.

The writer has operated upon 3 such cases and has seen a fourth. In 1 case death occurred from metastasis to the spine after operation. A second case has remained well three years after operation. In a third case the growth was removed before the breast had become infected, the patient being alive and well four years after the operation.

Symptoms of Cancer of the Breast.—The first symptom noticed is a hard lump in some portion of the mamma, accidentally discovered by the patient. It is not painful, and there is no constitutional disturbance. If such a nodule appears in a healthy woman from forty-five to fifty years of age, the chances are strongly in favor of its being a malignant growth. The nodule may be seated in any of the regions of the breast, but it is more frequently found in the upper and inner quadrant. The nodule is hard to the touch and is ill-defined as to its borders. A careful inspection of the surface of the breast when the disease is somewhat more advanced will show that the skin overlying the tissue is depressed slightly, forming a fold or a shallow dimple. In some cases, particularly those in which the nodule is centrally situated, and in the more advanced stages of the disease, the nipple also is depressed. This pitting of the skin is due to the invasion of the ligaments of Cooper (Fig. 145 and Plate 3), which, as has been shown, furnish support both to gland-tissue and to lymphatic vessels. Destruction of these connective-tissue bands causes a shrinkage which drags down the skin. The retraction of the nipple is due to destruction of the larger ducts.

As the nodule increases in size the depression of the skin becomes more marked, until finally the skin is attached to the growth. Infiltration of the skin next occurs; finally the integuments soften and break down, and eventually an ulcer may form. In the meantime the adjacent portions of the gland are invaded, and finally the whole breast may become a brawny mass of cancerous infiltration. Usually the changes take place slowly, and in the scirrhous form months may elapse before a perceptible enlargement of the original nodule has taken place. The growth occurs backward also, and the pectoral fascia is invaded; the tumor then becomes adherent to the pectoralis major muscle. Meanwhile the glands in the axilla become enlarged. The cluster first infected is that lying beneath the margin of the pectoralis muscle. A

PLATE 3.

Carcinoma of the breast; extension of the disease to the surface through the ligaments of Sir Astley Cooper.

nodule may also be frequently felt near the apex of the axilla. The sensation imparted to the fingers is somewhat characteristic. These glands are larger than ordinarily inflamed or hypertrophied glands, and several are often matted together, the conglomerated mass presenting facets produced by pressure against the adjacent structures. Any very material increase in size of the axillary glands or matting together must be regarded with suspicion. As the disease advances the axilla becomes distended with enlarged glands and the supraclavicular region may be

FIG. 145.—Scirrhous carcinoma.

invaded, particularly the glands in the posterior cervical triangle. A very considerable infection of the lymphatic glands around the large vessels is attended with a diminished return of blood through the veins and lymphatics. As a result, swelling of the hand and arm occurs, and the enlargement may at times be very great. At this period of the disease, generally during the second year, the bronchial glands may be infected.

When the disease originates in the inner hemisphere of the mamma, the extension of the line of infection may be in the direction of the sternum. We then find nodules at the border of the sternum, and on dissection it is seen that they become continuous with a chain of enlarged

glands in the mediastinum. From this point the disease may spread along the subpleural surfaces of the intercostal regions (Fig. 146).

The period at which the axillary glands are infected varies greatly. This region may be invaded within a few weeks from the time the primary nodule makes its appearance. In a few cases, and these are

FIG. 146.—Infection of mediastinal glands and pleura in a case of advanced cancer.

quite rare, the axilla is found not infected several months after the development of the disease in the breast.

The extension of the disease to the skin above occurs also through lymphatic infection, and is much more extensive than appears to the naked eye. Hence the frequent recurrence of the disease in the pectoral region after operation. In the more malignant forms of carcinoma the skin-infection is sometimes very extensive, and the whole chest eventually becomes infiltrated by cancerous nodules (*cancer en cuirasse*).

Secondary deposits of cancer in the viscera are found usually at the end of two years from the beginning of the disease. The liver and the lungs are the most frequent seats of these metastases. Almost any organ may become infected. Secondary nodules are not infrequently found in the bones, as the sternum, the ribs, and the humerus.[1] Spon-

[1] According to Snow, when the lymphatics of the axilla are obstructed by the disease, diversion of the current takes place in abnormal directions, and the lymphatics coming from the adjoining humerus may convey a deposit to that bone. According to the same author, the sternum is invaded through an infection of the thymus gland. This marrow-infection is quite insidious, and four or five years may elapse in the atrophic forms before the deposits manifest themselves.

taneous fracture of the femur is occasionally observed as the result of softening of the bony tissue by a cancerous nodule. In rare instances a carcinomatous nodule may be found in the opposite breast; but it is doubtful whether the disease spreads directly from one breast to the other.

Cancerous cachexia is a symptom caused by the absorption of the broken-down tissues which are formed by the destruction of the healthy and morbid tissues during the progress of the disease.

It may be more or less marked while the disease is still localized. The improvement in health after an operation is doubtless due to the removal of the morbid products and the arrest of the process of absorption. When the metastatic deposits multiply, cachexia becomes well marked and is characterized by anemia and emaciation. The *average duration* of life in carcinoma of the breast is, according to Gross, 28.06 months; but this period may be greatly prolonged in some of the chronic types of the disease, such as the atrophic scirrhus. Patients affected by this form of cancer may live for ten or fifteen years.

The **diagnosis of cancer of the breast** often presents great difficulties in the early stages, but is comparatively easy when the disease is well advanced.

The presence of a hard, ill-defined lump in the breast in a woman between forty and fifty years of age is strongly suggestive of cancer. Other very characteristic symptoms are the dimpling of the skin in the neighborhood of the tumor (Fig. 145), or the retraction of the nipple if the disease is situated near the center of the organ. An examination of the axilla reveals in the great majority of cases the presence of enlarged glands, especially beneath the border of the pectoralis major muscle. The hardness and matting together of these glands are peculiarities highly characteristic of cancer.

In the more advanced stages of the disease the adherence of the skin, the gradual involvement of the mammary gland, the peculiar hardness of the tissues, and the increase in size and number of the infected glands in the axilla make the diagnosis a comparatively simple matter. In still more advanced cases the presence of an ulcer on the breast, the lenticular nodules in the skin of the chest, and the enlargement of the supraclavicular glands are all frequently observed symptoms.

The presence of a discharge from the nipple is comparatively rare. This symptom is more frequently observed in cystic disease and in villous papilloma.

Treatment.—The only remedy for this disease is a complete removal of all infected areas. The operation is not, however, indicated in very advanced cases, such as those in which the tumor has become adherent to the ribs and there is extensive involvement of the skin. Involvement of the supraclavicular glands does not always contra-indicate operative interference.

Operation.—An operation for the removal of cancer of the breast must take into consideration the routes through which infection of the neighboring structures takes place. The structures in which the disease is most likely to recur after the breast has been removed are the integu-

ments of the breast, the subjacent muscles, and the glands of the axilla. The modern operation (devised by Halsted) has therefore been extended so as to include all these parts. It should contemplate a removal of the gland, paramammary tissue, and the integuments in sufficient amount to include the superficial lymphatic vessels; a removal of the sternal portion of the pectoralis major muscle and division or removal of the pectoralis minor muscle; a careful dissection of the axilla, and, in doubtful cases, of the posterior cervical triangle.

The details of the operation as performed by the writer are as follows: An incision is made from the anterior margin of the axilla along its anterior border, or slightly above, and the line of the pectoralis

FIG. 147.—Author's incisions in removal of breast for cancer.

major muscle around the lower border of the breast to a point on the boundary-line of the inner and lower quadrant. A second incision begins at the middle of the anterior axillary fold and gradually diverges from the first incision as it approaches the breast, when it sweeps around the upper border of the organ to meet that incision again at its terminal point. The amount of skin thus included is pear-shaped, the point being at the upper axillary margin (Fig. 147). The direction of these incisions varies somewhat according to the locality of the nodule; but a very large amount of tissue should be surrounded by them, usually the whole breast, and occasionally a portion of the adjacent

integuments. The edges of the wound should be reflected back and the dissection made so as to expose the margin of the mammary gland. The knife is now carried down to the pectoralis major muscle, which is freely exposed along the line of the whole upper incision. The sternal portion of the pectoralis major muscle is now separated from the thorax, and the whole mass to be removed is thrown outward. The muscle is divided near its humeral insertion. This exposes freely the pectoralis minor and the axilla. Should the upper incision have been carried some distance below the clavicle, a third incision may now be made at right angles to the first, so as to lay bare the axillary vessels up to the point where they pass beneath the clavicle. The pectoralis minor should now be divided and its halves reflected or removed. The dissection of the axilla follows next, the axillary vessels being carefully cleansed of all adipose tissue from their point of emergence beneath the clavicle down to and through the axilla. Special attention should be paid to a prolongation of adipose tissue which lies in front of the vessels, and a similar tongue of tissue which runs up behind them. A thin, blade-like mass of adipose tissue lying between the serratus magnus and the sub-scapularis should also receive the attention of the surgeon, for here numerous shot-like glands are found in the more malignant forms of the disease. As the dissection of the axilla proceeds the branches of the large vessels are cut and tied, and also any thoracic or scapular nerves which interfere with a thorough cleansing of the part. The contents of the axilla are now reflected outward, together with the mamma and pectoral muscles; a few long sweeps of the knife loosen the outer attachments of the mamma, and the whole infected area is separated from the body in one continuous mass.

If there is reason to suspect an infection of the supraclavicular glands, the vertical incision should be extended above the clavicle; the posterior cervical triangle can thus be exposed and its contents dissected. Division of the clavicle does not add materially to the exposure of the region.

The margins of such an extensive wound cannot be approximated. It is the custom of many surgeons to allow this wound to granulate, and to cover the granulating surface with skin-grafts or to graft immediately. A better plan is to cover in the wound by a flap taken from the side of the thorax and turned up from the lower margin of the wound. An incision can be made at the middle of the lower lip and at right angles to it. The knife should be carried in a gentle curve downward or upward as preferred, or in both directions, and the flap or flaps can be so spread out as to cover in the greater portion, if not all, of the exposed surface. This enables the operator to attain that much-to-be-desired result, healing by first intention (Figs. 148–150). A small strand of sterilized gauze should be retained between the edges of some portion of the wound for the first twenty-four hours to drain the large amount of serum which escapes from the wounded lymphatic vessels. This should be removed on the second day, and a provisional suture left there for the purpose should now be tied. A voluminous aseptic dressing should be applied, in which the arm should be included.

The mortality of this operation is at the present time very small, and may safely be placed at 2 per cent. Many operators have a clean record of 100 consecutive operations without a death.

The results of operations for the cure of cancer of the breast are
constantly improving.   A disease which was supposed by the previous
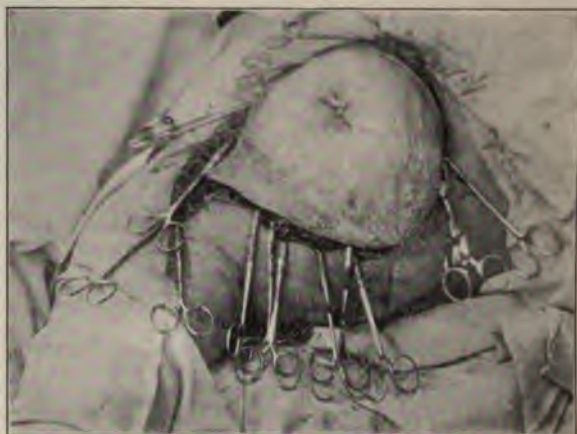
FIG. 148.—Preliminary incision in excision of the breast for cancer.

generation of surgeons to be incurable gives a percentage of those
which have passed the generally accepted three-year limit as high in

FIGS. 149, 150.—Scars showing incisions as made in Fig. 147.

some cases as 50.   Such results could, however, be obtained only in
selected cases, as many cases which come to the surgeon are, owing to

the tendency on the part of the patient to keep her disease a secret, beyond the reach of the knife. In 30 cases operated upon by the writer since January 1, 1893, 12, or 40 per cent., remained alive and well at the end of three years.

THE MALE BREAST.

The male breast is situated principally over the fourth intercostal space, or over the fifth rib. The average distance from the median line is 10 to 12 cm. (4 to 4.7 inches). The nipple is chiefly elliptical in shape, rarely circular. The gland in the male has a circular or disk shape, or sometimes an oval or trefoil outline. It is thickest at the center and tapers off at the periphery (Schuchardt). Similar changes are noticed at birth in the male to those already referred to in the female. There is frequently a slight enlargement, and sometimes a slight discharge of a milky fluid. At times this may be accompanied by a congestion, which

FIG. 151.—Gynecomastia.

may lead to inflammation and even suppuration. The secretion of milky fluid begins after the separation of the cord, lasting from about the sixth to the tenth day. At the time of puberty a painful swelling occasionally occurs, which disappears ordinarily at the expiration of two or three weeks. The symptoms may become more marked, and abscess may even rarely develop. When the process continues over a considerable space of time, it may eventually be followed by a permanent enlargement of the breast. The condition, which is in reality merely

an exaggeration of the ordinary processes of development, has been described as **mastitis pubescentium virilis** (Langer). According to some authors, the left breast is more often affected than the right.

Gynecomastia signifies a development of the breast in the male similar to that in the female. Well-formed glandular structures are occasionally found in such breasts. In some cases only fibrous and adipose tissues have been found. Many cases, however, are reported in which secretion of milk has taken place, particularly in ancient times. Dennis regards this condition as a further development of that above alluded to as "mastitis pubescentium virilis." Dennis calls attention to the statement that gynecomastia is said to be very common in Pomerania. At the present time it is, however, in most countries very rare, for Puech shows that, according to French military statistics, it occurs only once among 13,000 conscripts. The accompanying portrait (Fig. 151) is of an individual who exhibited himself as " half man, half woman."

This malformation is found in cases in which the sexual organs are normal. Williams considers that cases of this kind are probably due to reversion to the condition prevalent when the males aided the females in suckling their young.

The growth occurs usually about the time of puberty, and more frequently only one breast, principally the left, is affected. In a second type of case the sexual organs are affected. Congenital malformations, especially the different degrees of hermaphrodism, are accompanied by enlargement of the breasts.

Mason Warren[1] reports a case of a man, about twenty-one years of age, from whom he removed a sarcomatous right testicle. The patient died of pyemia, and at the autopsy a uterus with well-formed tubes and left ovary was found. There was also a prostate gland. The external genitalia were those of an hermaphrodite.

Gynecomastia is also associated with gigantism of the corresponding upper extremity.

Castration, when performed in early youth or in individuals over thirty years of age, does not appear to affect the breasts; but when performed during the period of greatest sexual activity the operation may be followed by enlargement of the breasts. Diseases of the testis, such as syphilis or mumps, which are followed by atrophy of both testicles may produce the same effect. Gonorrheal affections do not cause this result, as this disease affects principally the epididymis.

Among the **benign tumors** there may be found in literature examples of nearly all those characteristic of the female breast.

Adenoma.—Williams cites 3 cases of villous papilloma, and Schuchardt mentions 2. Mention is also made by other writers; but as the tumor is so often confounded with cystic fibroma, it is uncertain how frequently this form of growth occurs in the male.

Fibroma is mentioned as occurring in the pure form very rarely. Cases of "fibro-adenoma," or "cystic fibroma," are, however, more common.

Myoma.—Virchow reports the case of a man, thirty-two years of age, in whom there were a dozen tumors the size of a cherry in the

[1] *Surgical Observations, with Cases,* 1867.

vicinity of the mamma. A microscopic examination showed them to be almost entirely muscular. Large vessels and nerve-fibers are also found in the tumors.

Other rare forms of disease, such as angioma, lipoma, and chondroma, are occasionally observed.

Involution-cysts are described by J. A. Williams, Morgagni, and others. In the Hunterian Museum there is a cyst of the male breast presented by Pearce Gould. According to Schuchardt, they are quite common. The cases cited by this author appear to have been in individuals varying from fifty-five to sixty-one years of age.

Tuberculosis of the male breast appears to be an exceedingly rare affection.

Chronic mastitis is occasionally seen in the male breast. The writer has seen 2 cases of indurated nodules of the breast in men of about forty-five to fifty-five respectively, which lasted for several months and then disappeared. No special cause was assigned for their development.

Scirrhous cancer is the form of malignant disease most commonly
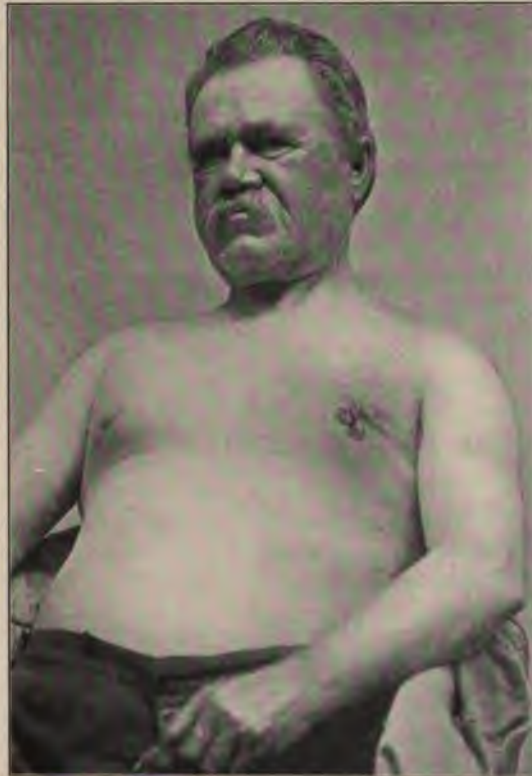
FIG. 152.—Cancer of the male breast.

observed in the male breast, although cases of medullary carcinoma, melanotic carcinoma, and sarcoma are also reported. Carcinoma is said

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to occur about once in 50 cases (Fig. 152). The writer has had but 1 case of carcinoma of the male breast in the last 100 cases.

The patient was fifty-nine years of age ; six years before, without apparent cause, a small lump had appeared near the nipple. Five years before it had been drawn out by a plaster, the operation being repeated a year later. At the time of seeing this patient, February, 1887, a small lump was felt near the old scar, firmly attached to the pectoral muscle. The glands in the axilla were enlarged. The scar and part of the pectoral muscle were removed and the axilla was dissected. The microscopic diagnosis was "cancer." Up to 1894 there was no report of a return of the disease. There were then some dyspnea and cough, with edema of the face and hands. The patient died October 16, 1895. There were some enlargement of the liver and dulness over portions of the chest ; no local recurrence. No autopsy was made.

According to Williams, the tubular form of cancer is quite common. This, he points out, is what might have been expected, as the ducts are the predominating feature of the male breast. Medullary as well as melanotic cancer is also reported. The average age at which cancer of the breast appears in the male is, according to Williams, fifty years. The tables given by various authors do not show clearly whether the scirrhous or medullary forms predominate ; but a perusal of a large number of cases reported by Schuchardt shows that the scirrhous type is apparently the prevailing one. An analysis of 18 fatal cases by Williams gives the average duration of life at sixty-one months, which is more than double that allowed by Gross for cancer in the female breast.

Wagstaffe reports a case of removal of both breasts in a man for scirrhous cancer. Cases of Paget's disease and of forms of cutaneous cancer of the breast are reported, but appear to be comparatively rare.

The **treatment** of cancer of the breast in the male should differ in no respect from that laid down for the female breast.

Sarcoma of the male breast is occasionally observed. In 25 tumors of the male breast tabulated by Williams there were 16 cases of cancer and 3 of sarcoma.

CHAPTER VIII.

THE TECHNIC OF ABDOMINAL SURGERY.

Nomenclature.—At the time of the introduction of Abdominal Surgery the term " gastrotomy " had been used to denote the operation of opening the abdominal cavity. In England this term gave way to " abdominal section," and in America to " laparotomy." The latter term is derived from λαπάρα, the flank. The term " celiotomy " (κοιλία, belly) has recently been substituted for these various names by many writers.

Preparation of the Patient.—Before the ordinary operations of pelvic surgery the patient should be cautioned to eat sparingly of food for two or three days: thirty-six hours before, a cathartic should be given. Half an ounce of castor oil or the same amount of Epsom salt is usually ordered. In operations for resection of the intestines a longer period of preparation is desirable, and the use of liquid diet and cathartics should be maintained for several days. Before operations on the stomach, it is desirable that the stomach be washed out with boric-acid solution (2 per cent.) once a day for three or four days. The diet on the day before all abdominal operations should consist of liquid food without milk, as in this way the smallest amount of residue accumulates in the lower bowel. The patient should take a warm bath some time during the day, after which the skin of the abdomen should be carefully prepared. The method of preparation varies greatly with different surgeons. The following is the routine method at the Massachusetts General Hospital:

The abdomen is shaved, and all hair is removed from the vulva as well as from the pubes. A poultice of soft green soap is applied and left on from two to four hours. The skin is next scrubbed with soap and water, then washed with chlorinated soda (1 : 10), and next with ether to remove the last remnants of oily substances. The skin is now disinfected, first with hydrogen peroxid and afterward with a solution of corrosive sublimate (1 : 1000). A gauze and cotton poultice soaked in a solution of corrosive sublimate (1 : 5000) is then applied and left on all night.

On the morning of the operation this corrosive dressing should be changed and a vaginal douche of corrosive sublimate (1 : 5000) given. In all operations upon the female pelvic organs, and especially before hysterectomy, thorough preparation of the vagina is necessary. This should consist of daily cleansing with green soap and water, followed by corrosive douches for two or three days previous to the operation. On the morning of the operation no food but a cup of beef-tea or broth should be allowed. It is necessary that on the morning of the operation an enema should be given; this may be simple soapsuds or may contain glycerin.

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Patients in feeble condition may require some form of stimulation for a longer or shorter time before the operation. Strychnin in moderate doses may be given for several days, and just before the operation a small quantity of brandy, with or without strychnin, and morphin may be advantageous. It is of the greatest importance to be sure that the bladder is thoroughly emptied, preferably by catheter, just before the operation.

The patient should be warmly clothed; a light undershirt may be worn beneath the night-dress, and stockings should protect the legs. If hot-water bottles are used, great care should be exercised while the patient is under the influence of the anesthetic, and it is well to avoid their use except in cases of well-marked shock.

Arrangement of Operating-rooms.—The equipment of hospital operating-rooms has been discussed elsewhere; what follows refers to operations in the rooms of a private house. No elaborate preparation is necessary. The room should be swept and cleansed the day before; superfluous draperies should be removed, and curtains so arranged as to afford plenty of light. The furniture and wood-work of the room should be washed with corrosive sublimate or carbolic acid at least as recently as the day before the operation. If these arrangements cannot be made the day before, they should be omitted, as recent sweeping will render the air less pure. The temperature of the room should be at least 75° F. When possible, a special operating-table should be used, upon which the patient may be placed in the Trendelenburg position—a position which is almost universally employed in the United States in pelvic surgery. The dimensions of such a table should be about as follows: Height, 34 inches; length, 6½ feet; width, 24 inches. A suitable table can always be improvised. Two or three small tables are necessary for instruments, sutures, and sponges, as well as for disinfecting and irrigating solutions and dressings. These tables should be covered with sterilized towels. The solutions needed are a saturated solution of potassium permanganate, a saturated solution of oxalic acid, hydrogen peroxid, corrosive sublimate, sterile salt solution or sterile water.

The towels, sheets, and dressings used in the operation, as well as the clothing of the patient and the gowns of the surgeon and his assistants, should be thoroughly sterilized. The surgeon or one of his trained assistants should be responsible for the sterilization of these. In many large cities manufacturers of surgical dressings are prepared to supply a modern operating-table and all sterilized supplies. Usually the surgeon prefers, however, to supply his own sponges (Fig. 153).

The instruments should be boiled in a 1 per cent. solution of sodium bicarbonate and water and placed with the towel which holds them upon the instrument-table, where they should be exposed only at the last minute. Instruments vary with the ideas of the surgeon. They should not be too numerous. The surgeon should learn to work with simple tools. A dozen small and half a dozen large hemostatic forceps are usually sufficient. Two pairs of long-toothed dissecting-forceps are for the use of the surgeon and his assistants throughout the operation. Two broad and two narrow retractors, a Cleveland needle, or an aneurysm-needle, a blunt dissector, two pairs of blunt scissors, large

and small double hooks, and two scalpels complete the list of instruments usually needed; but in operations for large intra-abdominal tumors, and especially for hysterectomy, three or four pairs of large clamp-forceps—"Spencer Wells forceps"—will be necessary. Specially devised instruments are to be avoided; all instruments should be nickel-plated.

The anesthetic had better be administered while the patient is still in bed. To many patients the details of a modern surgical operation would be shocking, and they should be spared all signs of preparation.

The patient having been anesthetized and placed upon the table, the skin of the abdomen should again be scrubbed with soap and water and thoroughly disinfected with corrosive sublimate and alcohol. All

FIG. 153.—Patient prepared for operation. A perforated sheet covers patient and anesthetizer and exposes the field of operation.

chemical solutions should be washed from the skin of the abdomen with sterile salt solution or sterile water before beginning the operation. The patient should be covered with sterilized sheets and towels, leaving no part exposed save a suitable opening for the field of operation.

Ligatures.—The ligatures may be either silk or catgut. Catgut is preferable in septic wounds, because it is absorbed, and one cause of future sinuses is thus avoided. It is not so secure a ligature as silk. Silk ligatures may be used in all aseptic operations, although many surgeons regard them as a possible source of irritation under any conditions. All ligatures should be thoroughly sterilized beforehand; silk ligatures may be re-sterilized at the time of the operation by boiling them with the instruments.

Sponges.—Sea sponges require tedious methods of cleansing and cannot be sterilized by steam; they are therefore no longer used at the Massachusetts General Hospital. They do not possess any advantage over the dry absorbent-gauze sponges, "handkerchiefs," and towels. These are made from what is known as No. 2 or No. 3 absorbent gauze. Pieces of the gauze 12 inches in length are folded to form a pad about the size of the palm of the hand. These are used as sponges; or, attached to forceps, may be used to wipe clean the various recesses of the abdominal cavity. Gauze cut in one- or two-yard lengths is used for walling off the intestines from the field of operation; owing to their size and absorbing power, these gauze handkerchiefs or towels are most useful in protecting the viscera from injury and contamination. All sponges should be absolutely sterilized, and the number of sponges used in the operation should be accurately known. It is of the greatest importance that no foreign body be left behind in the abdominal cavity after the operation; and to prevent this a careful count of all sponges and hemostatic forceps should be made by the surgeon and his assistants before the operation and again before closing the abdominal wound.

Irrigating Solutions and Restoratives.—Sterile salt solution should be the irrigating fluid for the exterior and interior of the abdomen; it must also be used for rinsing the hands and arms of the operators during the operation. A large supply of this solution should be at hand; it can readily be prepared from saline tablets. The temperature of the irrigating solution should be at least 110° F. Salt solution is also of great value for subcutaneous injection in cases of shock or hemorrhage. Its use should not be confined to cases of hemorrhage; both injected subcutaneously and used as enemata, it is invaluable in cases of cardiac depression and collapse. One or two pints injected in this way will be quickly absorbed. Brandy and ammonia, strychnin, digitalis, and other cardiac and respiratory stimulants should be available.

Assistants.—The number of assistants should be reduced to those absolutely needed, as the chance of infection is thus diminished. An anesthetizer, one assistant, and one nurse are sufficient for many operations; but for the more difficult abdominal operations extra assistants may be required. The assistant should stand opposite the operator. The surgeon should stand on the patient's right when the latter is in the horizontal position, but on the left when in the Trendelenburg position; the nurse should stand near the assistant. Long sterilized gowns should be worn by all. Sterilized caps are now generally worn. Some surgeons use sterilized masks. The mask is an additional protection if the surgeon wears a long beard or is obliged to lecture while operating, especially in cases of large abdominal wounds. Cotton gloves are now less used than formerly, as they are easily saturated. Rubber gloves have come into general use for abdominal surgery, and as at present manufactured interfere but little with the tactile sense.

Preparation of the Hands.—The hands of the surgeon and all assistants should be scrubbed for ten minutes with soap and hot water, using a sterilized nail-brush. Particular attention should be paid to the finger-nails—they should be kept short, and after scrubbing with soap

and water the hands and arms should be washed in ether or alcohol. After this they should be immersed in a saturated solution of potassium permanganate, and then completely decolorized in a saturated solution of oxalic acid, with or without the additional use of hydrogen peroxid, after which they are allowed to soak in a solution of corrosive sublimate (1 : 3000). Before operating all traces of these strong disinfectants must be removed from the hands and arms by rinsing them in sterile salt solution or sterile water. Corrosive sublimate or any strong chemical must not come in contact with the peritoneum.

Many surgeons are content to use only alcohol and corrosive sublimate as disinfectants after scrubbing the hands and arms in soap and water.

Incision.—The incision should give ready access to the field of operation and at the same time leave the structures of the abdominal wall in a condition most favorable for preventing subsequent hernia. The incision may go directly through the linea alba, or through the linea semilunaris, or through the muscles of the abdominal wall by blunt separation of the fibers. Undoubtedly an incision through intact muscular fibers is the best provision against hernia. The facts that the linea alba and the linea semilunaris have been so frequently selected for incision, and that ventral hernia has often followed abdominal section, would seem to prove that hernia takes place most frequently through fasciæ. An incision through muscular walls tends to make a more or less zigzag opening, muscular fibers retracting here and there beneath the cut edges of an elastic aponeurosis (see Fig. 29, Vol. I., p. 91). An incision through tendinous structures is more readily brought into apposition than one through muscle; but this advantage is more than offset by the greater tendency to hernia. It is possible that careful preservation of the nerve-supply of the abdominal muscles may, by preventing muscular relaxation, still further diminish the chances of hernia.

The usual incision for exploration or operation upon the pelvic organs is in the median line, between the umbilicus and the pubes. An incision from 3 to 4 inches long is generally sufficient. Such an incision is large enough for the introduction of the hand for the purpose of exploration of either of the lower quadrants. The incision may be carried downward, taking care to avoid the bladder, giving free access to the pelvic cavity ; or it may be continued above the umbilicus to avoid the ligaments and vessels which approach the median line at this point. An incision above the umbilicus in the median line permits access to the regions of the liver, the stomach, and the pancreas. Incisions through the lineæ semilunares give access to the gall-bladder and biliary ducts and the duodenum on the right, the spleen on the left, the kidneys and the ascending and descending colon. Incisions in the iliac region may be necessary to reach the appendix or sigmoid flexure, and in the flanks to reach the kidneys or the colon. There is a growing tendency among surgeons to make the incision directly over the organ to be operated upon, dividing muscular fiber by blunt dissection when possible. Many operations upon the gall-bladder, stomach, kidneys, and spleen are done through oblique incisions more or less parallel to and at no great distance from the border of the ribs.

An incision in the median line should be made as follows : The first

cut of the knife should expose the linea alba and the aponeurosis of
the rectus muscle; the cuts of the knife should be of equal length and
divide the tissues evenly. Vessels of any size should be caught by
hemostatic forceps. The aponeurosis of the rectus should be divided,
and the muscular fibers just on one side of the median line separated
by the handle of the knife or by a blunt dissector. The underlying
tissues should be divided carefully between dissecting-forceps until the
peritoneum is reached. This should be seized in the same manner,
when a small nick with the knife allows the entrance of air, which sep-
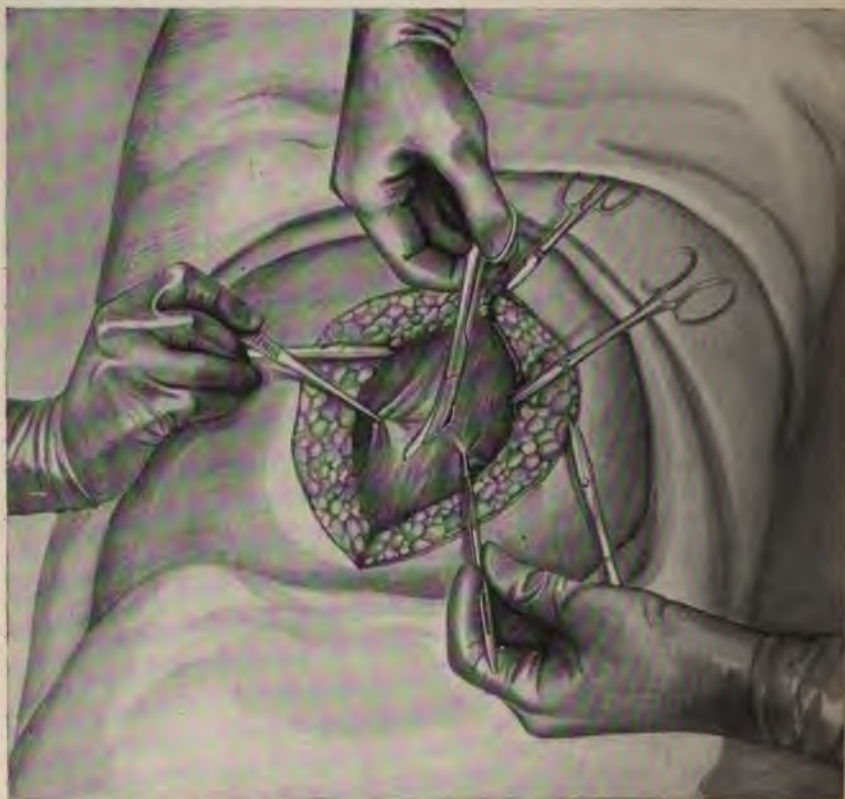
FIG. 154.—Opening the peritoneum; patient in Trendelenburg position.

arates the peritoneum from the underlying intestines. Further division
of the peritoneum and enlargement of the incision should be done with
scissors, cutting over the finger introduced into the peritoneal cavity
(Fig. 154). Many surgeons still prefer to make the incision directly
through the fibrous tissues of the linea alba going through the border
of the rectus.

Exploration should be done carefully, so that rough handling of the
intestines or pressure of a portion of them against the abdominal wound
may be avoided. If the operation is to deal with pelvic organs, it may
usually be done best with the patient in the Trendelenburg position, for

the entrance of air together with the action of gravity favors the falling away of the coils of intestines (Fig. 156). This position should be used even though pus be found. Suppuration in the Fallopian tubes is not infrequently sterile ; and, moreover, infected areas can be most thoroughly isolated by means of the " walling-off" process. This process consists in systematically spreading out large gauze handkerchiefs so as completely to cover over and shut out all parts of the abdominal cavity not to be included in the operation. Several of these large pieces of gauze carefully introduced will furnish ample protection against infection (Fig. 156). A free end should always remain outside of the wound. For deep sponging the smaller gauze pads may be used; these can be attached to long artery-forceps or sponge-holders, and used to wipe out the farthest

FIG. 155.—Opening of peritoneal cavity and exposure of tumor; patient in Trendelenburg position.

recesses of the abdominal cavity. Great care should be taken that no sponge or gauze be left in the abdomen after the operation. To insure the accuracy of the sponge-count made before the operation and to be verified at its close, no sponges or pieces of gauze should be cut, or torn, or taken from the operating-room during the operation. The large " walling-off" gauzes should be left untouched, if possible, throughout the operation.

The conditions in the abdominal cavity are too favorable to hemorrhage to allow the neglecting of any bleeding point. Such a point after closure of the wound becomes inaccessible, and hemorrhage will give no sign of its presence until grave damage has been done. All bleeding points should be caught by hemostatic forceps and securely tied. Large bands of adhesions and pedicles should be transfixed with

the Cleveland needle or some similar instrument, and tied in sections. The size of the ligature is governed by the size of the part to be tied. Care should be taken that no tension is made upon the part during the application of the ligature, and that too large areas of tissue are not ligatured, for relaxation of the tissues after removal of the clamp will favor slipping of the thread. Oozing must be met by temporary packing; if severe, it may lead to partial non-closure of the abdominal wall. If suppurating areas have been exposed, irrigation may be necessary; in which case care should be taken not to allow any of the fluid to leak into the protected regions. The "walling-off" gauze should be left in position, the patient lowered to the horizontal position, and the irrigating stream directed against the area in question with only moderate force.

FIG. 156.—Stump of uterus and pelvis exposed after hysterectomy by placing the patient in the Trendelenburg position and walling off the intestines with gauze handkerchiefs (half-diagrammatic).

For this localized irrigation a pitcher is the best instrument; for irrigation of the general peritoneal cavity, the irrigating-fluid should be introduced into all the deep recesses by some form of sterilized irrigating tube. After this the large gauzes should be removed and all fluids and débris wiped out with dry sponges, paying special attention to the deeper recesses of the peritoneum.

Drainage.—As surgical experience has grown and aseptic technic has improved, surgeons have resorted less frequently to drainage. Drainage should be considered during an operation when infection has been introduced, when trauma has been done to the peritoneum, when raw and oozing surfaces must be left, when general peritonitis or acute local peritonitis has been found. Hemorrhage may be a condition

demanding drainage. Until recently these conditions were invariably treated by drainage, but it was shown by Clark that in many cases contamination during the operation of a previously normal peritoneum with small amounts of pus or septic fluids, or the leaving behind of denuded surfaces from which blood or serum might collect in dead spaces, could be cared for better by the absorptive channels of the peritoneum than by any form of drainage, provided proper conditions were established. If the peritoneum is normal, it will dispose of moderate amounts of infection or hemorrhagic or serous oozing consequent upon operation. But a previously infected peritoneum cannot take care of contamination; therefore, all cases of acute local or general peritonitis must be drained. There is need of experience to determine how much infection can be disposed of safely without drainage. General rules may be laid down as follows: When moderate amounts of pus or septic fluids from pelvic abscesses or suppurating cysts have soiled the peritoneum during the operation, or when raw and denuded surfaces are to be left, or when it may be supposed that some infection has been introduced from without, Clark's method without drainage should be adopted. But when large amounts of pus have poured out into the general abdominal cavity, or when acute local or general peritonitis is present, drainage more or less complete is needed.

Clark's method of "postural drainage" is as follows: At the close of the operation all fluids and débris are carefully sponged out of the peritoneal cavity, after which thorough irrigation into every part of the cavity with hot sterilized salt solution is employed. After the irrigating fluid has returned clear, one or two pints are allowed to remain in the abdominal cavity, and the abdominal wound is closed without drainage. After the patient is put to bed the foot of the bed is elevated 18 inches for twenty-four hours. This favors the action of the intraperitoneal currents toward the diaphragm. It has been proved that the only absorbing channels of the peritoneum for foreign bodies are situated at the diaphragm, and that there are currents in the peritoneal cavity carrying foreign particles from the pelvis to these lymph-channels of the diaphragm, and that the action of these currents is favored by gravity.

Postural drainage has been proved reliable and safe in cases of moderate infection of a normal peritoneum by operation; it has not changed the principles of drainage necessary in acutely septic or extensively contaminated conditions.

The kind of drainage to be used in most cases should be gauze. Glass tubes have been abandoned by the majority of surgeons, because of the ease with which infection may be carried by them, and also by their tendency to cause necrosis and sinus-formation and even intestinal fistula. When it is necessary to drain large collections of pus, soft-rubber drainage-tubes surrounded by gauze should be used. But the cases are few in which gauze wicks will not answer every purpose. Strands or folds of gauze should be carried down to the diseased area, or to the recesses where fluid may collect, and led out of the abdominal wound. Harrington's gauze tapes are useful for this purpose. The ends of the external portion of the gauze should be cut off as often as dry. Gauze should be removed by the end of the fifth day, but in many

cases the gauze wicks may be removed in twenty-four to thirty-six hours, and their point of exit closed by sutures.

Sutures.—Suture material is various: silkworm-gut, silk, silver wire, catgut and animal tendon, especially the kangaroo-tendon, all have their advocates. Catgut and animal tendon should be mainly used for buried sutures. Silkworm-gut, because of its non-absorbable qualities and its pliability, is one of the most advantageous sutures. Faulty suturing may cause stitch-abscesses and ventral hernia. The sutures may include the whole of the abdominal wall. They should be introduced about $\frac{1}{4}$ inch from the margin of the wound and should include all

FIG. 157.—Through-and-through sutures, all applied before tying.

the tissues divided—they should number about three to the inch (Fig. 157). A gauze pad should protect the intestines during the insertion of sutures, and no stitch should be tied until all have been taken; superficial stitches may be inserted between them (Fig. 158). The necessary tension in this form of suture may create conditions favorable for suppuration along the suture-track. Care should be taken that no portion of the omentum or intestines is ensnared by this suture.

Many surgeons approximate the peritoneum with a continuous stitch of fine catgut or silk, thus shutting off the peritoneal cavity and preventing the edges of the peritoneum from being folded in. After this

methods of operation vary; some surgeons suture the remaining struct-
ures with one stitch, others suture the various layers separately by a
continuous or interrupted stitch (Fig. 159). In this form of suturing
the skin is usually approximated by the continuous buried suture of
silkworm-gut or silver wire. Suturing the peritoneum and the struct-
ures of the abdominal wall separately should be the method adopted

FIG. 158.—Tying a superficial suture between two deep sutures (silkworm-gut).

when possible, because by this method the dangers of sepsis to which
the external suture is exposed are avoided. When speed is needed the
through-and-through interrupted suture is the only one to be used.

Sutures should not be removed until the scar has become sufficiently
firm not to yield to tension. Stitches are usually removed from the
tenth to fifteenth day. One of the advantages of buried sutures is the
fact that by remaining in position they insure firm union of the parts.

Whenever muscles have been divided, great care should be used to
secure accurate apposition of the fibers by suturing with catgut or
animal tendon.

Dressings.—Aseptic abdominal wounds demand a plain aseptic dressing and its successful maintenance in an aseptic condition. The usual dressing consists of plain sterilized gauze next to the wound, covered by layers of absorbent cotton and sheet-cotton, all held firmly in place by a broad swathe and perineal straps; the whole dressing should be thoroughly sterilized by steam (Figs. 160, 161).
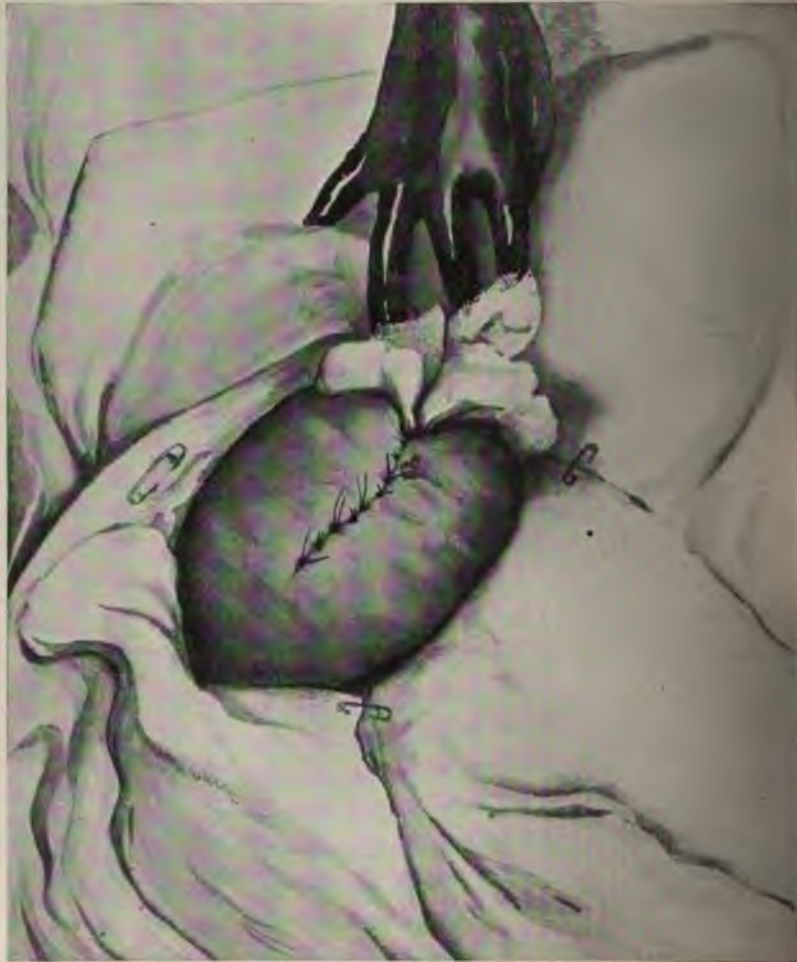
FIG. 159.—Gauze drainage; patient still in Trendelenburg position.

A few surgeons use a collodion dressing over the line of sutures and dispense with the swathe. This method has not been generally accepted.

After-treatment.—In a case progressing steadily toward convalescence little after-treatment is needed. The use of morphin to relieve pain in the first twenty-four hours is one about which surgeons disagree. It may be well immediately after the operation to give a small amount

of morphin and strychnin subcutaneously, but after this the use of anodynes should be avoided.

In a condition of shock the body-heat should be established by clothing and artificial heat; but care in the use of hot-water bags is

FIG. 160.—Application of dressing consisting of several layers of gauze. . The arrangement of the night-shirt so as to secure the hands of the patient during the operation is also shown.

necessary lest they come in contact with the skin of the insensible patient. The foot of the bed should be elevated and absolute quiet and rest secured. Cardiac stimulants are exceedingly valuable, but should

FIG. 161.—The swathe held by perineal straps.

not be abused. Strychnin in doses of $\frac{1}{30}$ grain is of the greatest value. Enemata are most valuable in this condition. In all cases of shock, whether from hemorrhage or cardiac collapse, large enemata of salt solution, with or without the addition of brandy and black coffee, should

be used. The subcutaneous injection of sterilized salt solution has been proved of value in cases of shock, collapse, and hemorrhage.

After abdominal operations no food should be given for twenty-four hours and no water for the first twelve hours. Thirst is best relieved by enemata of salt solution, but the patient may rinse the mouth occasionally with warm or cold water. The first nourishment should be teaspoonful doses of milk and lime-water, equal parts, given once an hour. The amount of this nourishment should be gradually increased for forty-eight hours, during which time it should be the only food. On the third day the diet may consist of milk-toast, beef-tea, chicken-broth, and milk ; solid food is not given before the fifth day. In favorable cases gas may be passed from the bowels in from twelve to twenty-four hours. The urine should be drawn by catheter if not passed within twelve hours.

The chief danger to be watched for in the first forty-eight hours is beginning peritonitis. The signs pointing to this condition are vomiting, tympanites, and a steadily rising pulse; temperature will vary and is not a reliable sign. During the first twelve hours vomiting may cause no uneasiness ; its continuation, associated with distention and a rising pulse, points to peritoneal infection and intestinal paralysis. This condition at the end of the first twenty-four hours must be vigorously treated. Intestinal action should be induced by cathartics, enemata, and the rectal tube. One-half a Seidlitz powder or 1 dram of Epsom salt may be given every half-hour until catharsis is obtained, or $\frac{1}{5}$ grain calomel may be given every hour for ten doses, followed by a Seidlitz powder. Distention and intestinal paralysis may not be relieved without the use of high enemata of turpentine, aloes, glycerin, and suds. A feeble and rapidly rising pulse is best treated by full doses of strychnin. Vomiting may be moderated by sips of hot water or black coffee, by small doses of cocain, or by bits of ice. In many cases moderate distention without vomiting may occur between the first twelve and twenty-four hours, and this is best relieved by the use of the rectal tube or a simple turpentine and glycerin enema. Uneventful cases require almost no treatment, and may be allowed to get up gradually at the beginning of the third week. It is wise to advise the use of a properly fitting support for from six months to a year after the operation, to protect the parietes from any sudden and undue strain.

CHAPTER IX.

THE DIAGNOSIS OF ABDOMINAL DISEASES.

ALTHOUGH the greater number of abdominal diseases are at first brought under the notice of the physician and subjected to medical treatment, the number of the cases is steadily diminishing in which the opinion of the surgeon is not sought with the view of assisting in the diagnosis or of suggesting the possibility of giving relief by operation.

The time has therefore passed when a surgeon may feel content to accept and act on the diagnosis already made for him by his medical *confrères*, leaving with the latter the responsibility of a possible error. Rather, he must himself go over the whole of the medical evidence and be prepared to supplement it by surgical methods, should such be required to elucidate the case or render possible an accurate diagnosis.

Facility in diagnosing is a gift which, though capable of being learned as an art by any competent and diligent student, is by some few acquired naturally, so that the diagnosis of even obscure and difficult cases is made out very rapidly by mental processes and methods almost incapable of description.

There is much to be said for the old adage, " If a man cannot diagnose a case in ten minutes, neither will he do it in as many hours ;" for, although there are many obscure cases necessitating prolonged study and observation before a diagnosis can be arrived at, these exceptions may be said to prove the rule.

The analysis of any surgical case necessitates both a general and a special inquiry ; the former involving the question of age, sex, occupation, habits, mental, moral, and physical conditions, and the history of both the patient and the disease; the latter including all information that the surgeon can elicit by physical examination.

While I feel that in no abdominal case should either the general or the special means of investigation be omitted, I propose to devote this chapter chiefly to a consideration of the special means available for the diagnosis of abdominal disease.

A knowledge of **regional anatomy** is of the first importance, since it must be borne in mind that diseases of special organs, especially tumors, make their appearance, as a rule, in the neighborhood of the organ from which they grow, though ultimately they may occupy the whole of the abdomen.
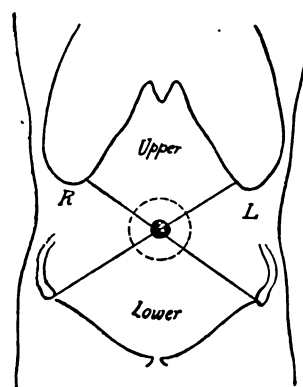
FIG. 162.—Diagram of the regions of the abdomen.

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The usual method of dividing the abdomen into **nine regions** is purely arbitrary, and is probably continued because it **has been** so long in use; but the fact of there being as many as thirty **different methods** of subdivision shows that as yet a really satisfactory **method has not** been arrived at.

I venture to suggest the use of two lines from the **lowest points of** the right and left anterior superior spines of the ilium **to the opposite** costal margins at the most prominent part of the ninth **costal cartilage** respectively, the lines crossing near the umbilicus, thus **dividing the sur-** face of the abdomen into a right and a left, an upper and **a lower region**; the immediate neighborhood of the umbilicus, in a **circle of 2 inches** around it, being known as the umbilical region (Fig. 162).

Possibly this method of mapping out the abdomen **has been sug-** gested previously; if so, I am unaware of it. It is the one to which I shall refer in my subsequent remarks.

The umbilical region contains—

1. The termination and division of the aorta and **part of the vena** cava;
2. Coils of the small intestine;
3. The stomach when dilated;
4. The transverse colon when full;
5. The remains of the umbilical vein;
6. The remains of the urachus and of the **omphalomesenteric duct**, both, at times, patent;
7. The termination of the duodenum;
8. The great omentum.

The superior abdominal region contains—

1. The liver;
2. The stomach, including the pylorus;
3. The gall-bladder and bile-ducts;
4. The spleen;
5. The duodenum;
6. The transverse colon;
7. The aorta and vena cava;
8. The solar plexus and semilunar ganglia;
9. The celiac axis;
10. The pancreas;
11. The lesser omentum, with the free border **containing the vena** portæ, hepatic artery, and common bile-duct, **and behind it the** foramen of Winslow;
12. The upper part of the great omentum.

The inferior region contains—

1. Part of the small intestine, chiefly ileum;
2. The bladder and the lower end of the ureters;
3. The prostate;
4. The rectum;
5. Part of the sigmoid flexure of the colon;
6. The uterus and its appendages;
7. The iliac vessels;
8. The lymphatic glands;
9. The hypogastric sympathetic plexus;

10. The lower part of the great omentum;
11. The inguinal canals, with the spermatic cord in the male and the round ligaments in the female;
12. The cecum and the vermiform appendix;
13. The lower part of the psoas muscles and their sheaths;
14. The lower part of the iliac fossæ.

The right abdominal region contains—

1. The upper part of the cecum, the ascending and hepatic flexure of the colon;
2. A part of the small intestine;
3. The right border of the great omentum;
4. A little of the right lobe of the liver;
5. The right kidney and adrenal and the commencement of the right ureter;
6. A part of the psoas muscle and sheath;
7. The upper part of the right iliac fossa.

The left abdominal region contains—

1. The lower and outer part of the spleen;
2. Part of the stomach, if dilated;
3. The left kidney and adrenal and the commencement of the left ureter;
4. The descending colon and the splenic and sigmoid flexures;
5. A part of the small intestine;
6. The left border of the great omentum;
7. Part of the left psoas muscle and sheath;
8. The upper part of the left iliac fossa.

After obtaining all the information that can be elicited from the patient and friends,

Inspection must always constitute our first diagnostic effort; and it is important that the patient should be in the dorsal decubitus, lying comfortably in a warm room, with the abdomen exposed to view. If the abdominal walls are kept rigid and fixed without distention, it will raise the suspicion of local peritonitis, especially if there are pain on movement and tenderness on pressure.

If there is distention of the abdomen, with fixation of the abdominal walls, marked tenderness, drawing up of the knees, a pinched expression, and general signs of serious illness, we should suspect general peritonitis.

Where severe pain exists, relieved by pressure and associated with restlessness and rolling about, especially on the face, colic should be diagnosed; and if there are visible contractions of the intestines through the abdominal walls, some form of obstruction of the bowel is rendered probable.

A distended abdomen associated with obesity or flatulent distention is usually not much out of proportion to the girth of the thorax and to that of the extremities; but a distended abdomen dependent on abdominal tumor or dropsical effusion will usually be out of proportion to the size of the chest, so that it is almost equally important to notice proportion as well as size.

The rounded distention of the front of the abdomen, especially if the prominence is a little more marked on one side than on the other, is as distinctive of ovarian tumor as the central, even rotundity is of preg-

nancy or of uterine myoma, or the barrel-shaped abdomen with bulging flanks is of ascites.

Tumors of individual organs may form localized swellings visible on inspection; for instance, cancer of the stomach not infrequently causes a bulging of the superior abdominal region (Fig. 163), and it may be seen to move up and down on deep respiration.

A tumor of the gall-bladder may form an easily perceived swelling starting in the superior and passing down into the right abdominal, or even across the umbilical into the inferior abdominal region (Fig. 164).
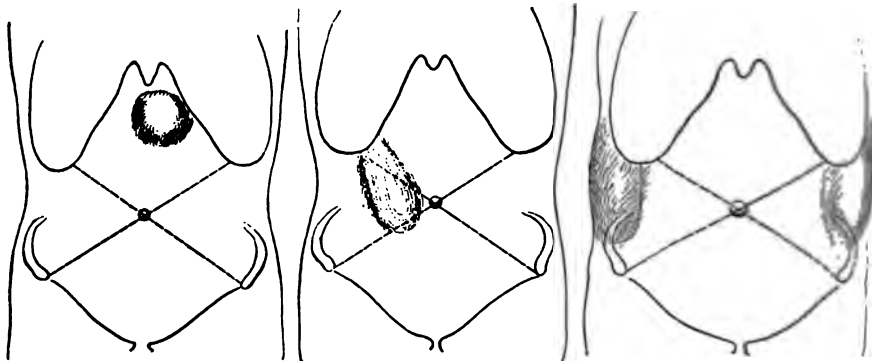
FIG. 163.—Bulging sometimes caused by cancer of the stomach.

FIG. 164.—Swelling caused by tumor of the gall-bladder.

FIG. 165.—Bulging caused by enlarged kidney.
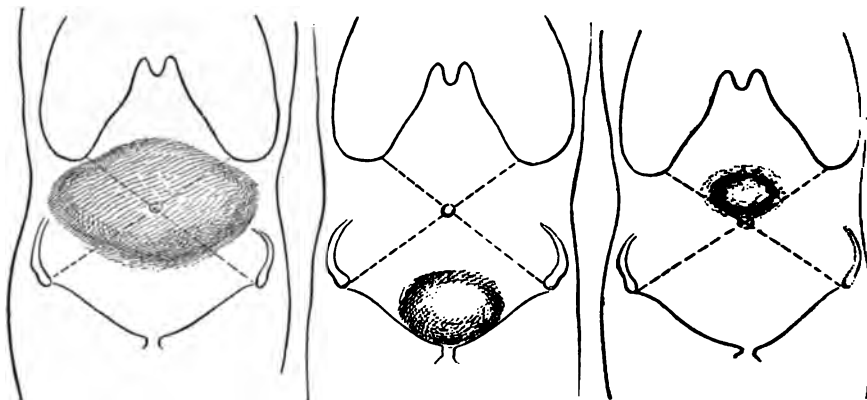
FIG. 166.—Tumor caused by a distended stomach.

FIG. 167.—Swelling caused by a distended urinary bladder.

FIG. 168.—Tumor caused by a pancreatic cyst.

An enlarged kidney may form a bulging in the right or left abdominal region (Fig. 165).

A distended stomach may form a tumor occupying all five abdominal regions (Fig. 166).

A distended urinary bladder will easily be perceived as a central swelling in the inferior abdominal region (Fig. 167).

A pancreatic cyst forms a very distinct fixed tumor in the superior abdominal region (Fig. 168).

Intestinal, cecal, and other tumors also frequently indicate their presence on inspection.

The umbilicus should be observed, as it sometimes gives valuable information. It will be found to be flattened out in ovarian or uterine tumor, and to bulge or to contain fluid in ascites or in tubercular peritonitis.

The veins on the surface of the abdomen are enlarged and often varicose where there is venous obstruction in the liver, as in cirrhosis and in some cases of malignant tumor; they are also enlarged in some cases of fibroid tumor of the uterus with pressure on the iliac veins.

In ovarian tumor an enlargement of the surface-veins may afford evidence of adhesions as well as of pressure.

The appearance of the skin must be noticed—whether edematous generally, as when the abdominal ailment is associated with general anasarca, or locally over a swelling when inflammatory, as in abscess associated with appendicitis. Local edema over a tumor is frequently of great diagnostic importance as distinguishing between growth and inflammation.

Thinning of the skin and of the parietes generally affords evidence of distention, and is usually well marked in large ovarian tumors.

The presence of lineæ albicantes associated with irregular pigmentation affords evidence of previous abdominal distention, as a rule dependent on former pregnancy, and may be very valuable in certain cases in which a reliable history cannot be obtained.

The fixation of the skin to any subjacent enlargement may be due to invasion by growth or to inflammatory adhesion. In the former case there usually will be enlarged vessels without edema and without local increase of temperature; in the latter case there is generally redness of the skin with increased temperature and local edema.

Palpation immediately follows inspection, and of all methods adopted for diagnosis, it is the one that we can least afford to omit.

With the patient supine in bed or on a couch, the head slightly elevated on a cushion and the knees drawn up, the muscles of the abdomen are relaxed as much as possible; they can usually be kept relaxed by talking to the patient, so as to divert his attention. The flat, warm hand placed on the abdomen at once perceives any irregularity or abnormality; the edge of the liver can nearly always be felt, and the character of the margin—whether rounded as in fatty liver, hobnailed as in cirrhosis, or bossy and irregular as in some forms of malignant disease. An enlarged gall-bladder, or kidney, or spleen; the presence or absence of any swelling of the pylorus; the distention or otherwise of the bladder; an accumulation of scybalous masses in the colon; enlarged glands; any solid tumor, or, in the case of a large tumor, any irregularity on the surface—all may be felt in a very brief space of time. It will be found better, as a rule, to slide the hand over the abdomen, and not to raise it from the surface; in fact, as a rule, the hand is not moved from its first position, but the parietes are made to slide over the internal organs, thus avoiding fresh defensive contraction of the muscles each time the hand is replaced on the abdomen.

It may sometimes be advisable to massage the abdomen gently for a time, to elicit the presence of a tumor due to contraction of a hollow

viscus. For instance, in hypertrophy of the pylorus a distinct tumor may be present at one time, owing to contraction of the muscular coat, and absent at another; and in intussusception the sausage-shaped tumor may be distinct when spasm is present, and imperceptible when the muscular coat of the bowel is relaxed.

In diagnosing between functional dilatation of the stomach and that due to obstructed pylorus the vermicular contraction of the muscular wall of the stomach elicited by manipulation is of the utmost importance, as are also the hardening and distention of the caput coli in cases of stricture of the large intestine. In making a diagnosis between myoma uteri and pregnancy the rhythmical contraction of the uterine wall in pregnancy, easily felt by the hand on the abdomen, may constitute an important diagnostic point.

Palpation is easiest in those patients whose abdominal walls are thin and relaxed; it is more difficult in cases of very fat or muscular parietes. Where, as occasionally happens, palpation is impossible on account of rigidity of the muscles or obesity, an anesthetic may be advisable.

Bimanual manipulation with one hand on the loin and the other on the surface of the abdomen enables the size of the kidney or the gall-bladder to be estimated and the character of any swelling in the loins to be ascertained. If needful, this bimanual palpation may be supplemented by inserting a finger in the vagina or rectum while the other hand remains on the surface of the abdomen.

Special resistance over any region may point to disease. For instance, tenderness and rigidity of the muscles below the right costal margin point to local peritonitis over the gall-bladder, a frequent concomitant of gall-stones; a tender and rigid epigastrium, to ulcer of the stomach; and rigidity of the muscles over the cecum, to appendicitis or to ulceration in the cecum, ileum, or ascending colon.

When a tumor is discovered, palpation will usually bring out its characters as to smoothness, irregularity, softness, or hardness. A nodular feel associated with free fluid in the peritoneum usually indicates malignant disease.

Pulsation may be elicited: if expansile, dependent on aneurysm or rapidly growing sarcoma; if non-expansile, due to a solid tumor resting on the aorta and being lifted up by it at each cardiac systole. In thin subjects the pulsation of the aorta may be easily felt, and may give rise to the suspicion of a pulsating tumor; but in such cases it is usually easy to feel the whole length of the vessel, and thus to diagnose the condition.

Between aneurysm and rapidly growing sarcoma it is sometimes almost impossible to make a diagnosis; but in the former the pulsation is usually more distinct, more expansile, and accompanied by a more marked bruit on stethoscopic examination. Moreover, a tumor may, and frequently does, arise at one or other side of the abdomen away from the aorta and vessels usually affected by aneurysm; nevertheless, some of the most careful observers have made mistakes in diagnosis in these cases.

Palpation will enable one to say whether the lump is solid or fluid, free or fixed, circumscribed or diffuse, smooth or nodular. A fluid tumor may be so firm to the touch as to feel solid, and it may be impos-

sible to elicit fluctuation. This is well shown in the case of a distended gall-bladder and in hydatid cysts; but in such cases a thrill can at times be obtained by gently flicking the swelling with the finger-nail while the hand is placed on the other side of the tumor. This method is of great service in demonstrating the presence of fluid in the peritoneum, when it is in too small a quantity to show the ordinary percussion-sign.

A fluid tumor will usually yield to the fingers on pressure and immediately resume its spherical form; whereas a solid tumor does not yield to pressure and is usually more irregular in shape, seldom being truly spherical, except in the case of some simple tumors, such as pedunculated myomata of the uterus. There is, however, an exception to this rule in the case of fecal tumors, which are irregular in shape, yield to pressure, and retain the impress of the finger.

Malignant tumors are usually irregularly nodular and hard; and though circumscribed and movable at first, they tend to become diffuse and fixed.

Fixation of a tumor may be dependent on inflammation; but in such cases the course is more rapid, and there are usually marked tenderness and sometimes local edema with other general signs of inflammation.

While palpating the abdomen, it is important to distinguish between surface-tenderness which may be reflected, and deep pain directly due to the disease which is being sought for. For instance, the reflected pain of appendicitis is usually above the umbilicus, whereas the deep pain at the seat of disease is at McBurney's point; again, the reflected pain of ovaritis may be beneath the costal margin, or along the crural branch of the genitocrural nerve where superficial tenderness can be elicited, whereas the deep pain is in the ovary itself, easily discovered on bimanual examination.

After palpating the abdomen with the patient in the dorsal position, a change of posture will often be useful. For instance, with the patient on the side a movable tumor will change its place and be more readily grasped. This is well shown in movable kidney or distended gall-bladder; as also in the early stages of pyloric or intestinal cancer before infiltration has occurred.

The genupectoral position is occasionally useful, as with the patient in that position, and the flat hands placed from behind over the front of the abdomen, an enlarged gall-bladder can be felt to fall into the hollow of the hand; and the margin and even the upper surface of the liver can in many cases be thoroughly examined. A floating kidney may in this way be easily palpated, and the hollow in the loin which it has left is most clearly demonstrated.

Free fluid in the peritoneal cavity or in a closed cyst does not give rise to a splashing sound on succussion; but where fluid is mixed with air, as in a dilated stomach or in a dilated bowel, a splashing sound can usually be elicited.

Vaginal examination in tumors originating in the pelvis is of the first importance. It may be carried out with the patient on the left side with the knees drawn up; or, better still, with the patient in the dorsal position with the thighs flexed, when with the right index finger or

index and middle fingers in the vagina, and the left hand on the surface
of the lower part of the abdomen, the whole of the pelvic contents may
be mapped out with great accuracy.

The uterus can usually be measured without the aid of a sound; the
direction of the fundus, the condition of the ovaries and tubes, the state
of the ureters, the condition of the bladder and urethra and of the
rectum can be ascertained.

In case of abdominal tumor, its connection with or freedom from the
uterus can usually be elicited and the character of the growth can often
be ascertained by palpation of its lower part in the pouch of Douglas.
If hard nodules are found in the peritoneal pouch, combined with fix-
ation of the uterus and associated with rapid deterioration of health,
malignant disease may usually be diagnosed, especially if there are signs
of ascites.   By vaginal examination the signs of pregnancy may be
elicited, and in doubtful abdominal tumors this method of examination
should never be omitted.   The ureters can readily be felt, especially if
diseased; and in tuberculosis of the kidney as well as in inflammatory
affections a vaginal examination will frequently throw additional light on
an obscure case.

Cancer of the base of the bladder can be felt by the finger in the
vagina, and tumor of the fundus can be discovered by bimanual exam-
ination, which at the same time will demonstrate the extent of infiltra-
tion from the size, shape, and mobility of the new growth.   In ascites
of obscure origin a vaginal examination should never be neglected, as
the presence of tubercular or of malignant masses in Douglas's pouch,
or of small ovarian or uterine tumors, may be discovered and prove the
key to the situation.

Rectal examination is of no less importance than vaginal; in fact,
it is almost universally applicable; whereas examination " per vaginam "
in case of unruptured hymen and in children is impracticable and usu-
ally undesirable, even if possible.   It may be adopted with the patient
in the dorsal decubitus, or in the left lateral position; and while I prefer
the dorsal position for vaginal, I think the lateral position is the better
for rectal examination, as when the knees of the patient are fully flexed
toward the abdomen, the abdominal muscles relax and render bimanual
examination easy.   The index finger should be well greased quite to the
base, and the patient directed to strain down while it is being introduced,
thus relaxing the sphincter and rendering the introduction of the finger
easy and painless.

In the female the cervix uteri can be plainly felt, as well as the whole
of the back of the uterus, the lower end of the ureters, the ovaries, and
Fallopian tubes; the condition of Douglas's pouch and its contents, if
any, can be made out; the contour of the pelvis, the shape of the coccyx
and sacrum, the pelvic glands, any effusion in the broad ligaments, and
the condition of the bowel itself can all be examined in less time than
the description can be given.

The diagnosis between inflammatory or hemorrhagic effusion in the
left broad ligament and similar swellings in the Fallopian tubes can be
differentiated more easily by a rectal examination than in any other
way.   On account of the anatomical arrangements of the peritoneal
folds on the left side, any effusion in the left broad ligament will sur-

round the rectum at a point within reach of the finger, producing a feeling of stricture which is entirely outside the rectal wall, and which, so far as my experience goes, usually disappears gradually when the cause is removed.

If any pelvic tumor is present, its attachments in the pelvis, its consistency, and other characters can be made out.

In cancer of the uterus, the pelvic glands if enlarged, and invasion of the broad ligaments if present, can be felt.

Though the vagina intervenes, a bimanual examination made " per rectum " will enable any tumor or thickening of the bladder to be made out.

An appendix when hanging over the pelvic brim can readily be felt " per rectum," and I have occasionally discovered in this way a tumor of the small intestine which had sunk by its weight into the lowest part of the peritoneal cavity.

Needless to say, fecal accumulation in the lower bowel causing diarrhea and other abdominal symptoms will be revealed by a rectal examination, which in fact should never be omitted in examining any abdominal case.

In the male, the state of the membranous urethra, the condition of the prostate, the implication of the ureters, enlargement of the vesiculæ seminales, the condition of the lowest peritoneal pouch, the state of the rectal walls, and the presence of any pelvic tumor may all be made out.

I am accustomed to estimate the size of the middle lobe of the prostate by the right index finger in the rectum and the left hand above the pubes; and this method is equally useful in estimating the nature and size of tumors of the bladder or prostate. In tumor of the bladder, if the swelling is soft, it will probably be a villous growth; if hard and nodular, probably a malignant tumor.

In children it is especially easy not only to diagnose stone in the bladder, but to tell its size by this simple method.

In a kidney affection a rectal examination of the ureters will frequently enable an estimate of its unilateral or bilateral character to be made; and in children it is possible to feel and diagnose a horseshoe kidney on examination " per rectum."

Vesiculitis is a much more common cause of pelvic peritonitis in the male than is ordinarily recognized, and this can only be estimated properly by a rectal examination.

Intestinal matting, tubercular peritonitis with scattered nodules, effusion in the peritoneum, too little to show in the abdomen, and intussusception, may all be frequently made out in this way.

Not only may the pelvis be thoroughly explored, but in young children, with the aid of an anesthetic, nearly the whole abdominal cavity may be examined by means of a finger in the rectum and a hand on the surface of the abdomen.

It has been suggested that examination of the interior of the pelvis and even of the abdomen may be made by the insertion of the whole hand into the rectum; but as the procedure is not free from the risk of rupturing the gut, and as the hand is firmly grasped when inserted and incapable of exerting its tactile function, the method is one which can be seldom, if ever, of real use.

Percussion of the abdomen, which may either follow or precede palpation, is a fine art which is capable of yielding most valuable information. It is not necessary to describe it minutely here, as it can only be learned by practice at the bedside.
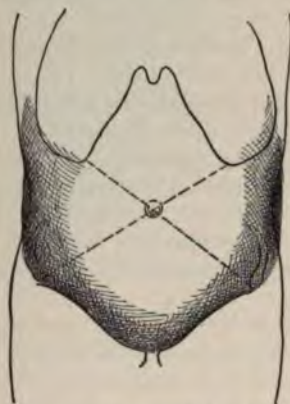
FIG. 169.—Diagram illustrating the percussion-signs in ascites.

Superficial percussion, in which very gentle taps on the abdomen are inflicted, will reveal dulness, owing to slight thickenings, thin layers of effused fluids, small tumors overlying distended bowel, and thin margins of organs with gut beneath, whereas deep percussion would reveal resonance.

On the other hand, deep percussion will reveal dulness in the case of tumors, effusions, and enlarged organs overlaid by intestines, where superficial percussion would only show resonance. Deep percussion is necessary where the muscles overlying the part are thick, as in the loins and in fat abdomens. The accompanying diagrams illustrate the percussion-signs usually found in ascites and in ovarian and uterine tumors (Figs. 169–171).

FIG. 170.—Diagram illustrating the percussion-signs in ovarian tumor.

FIG. 171.—Diagram illustrating the percussion-signs in uterine tumor.

Needless to say, however, percussion-signs alone would be utterly unreliable, as they vary with circumstances and need supporting by other evidence, such as palpation and inspection. For instance, ascites due to tubercular peritonitis may present a localized effusion almost exactly resembling an ovarian cyst; or if the effusion is in the middle line, it may resemble a uterine tumor; or if the intestines are adherent to the abdominal wall or matted together at one side the effusion may be unilateral. Again, general ascites may lead to dulness over the front of the abdomen if the intestines are tied down by a shortened mesentery or by a tumor in the mesentery.

Dulness in the flanks may be dependent on distention of the colon with fluid, and the similarity to ascites may be increased by change of posture increasing the dulness in the dependent and creating resonance in the elevated area; again, resonance in the flanks may be created by distention of the colon with gas, though there is free fluid in the peritoneal cavity. Extravasation of fluid in the peritoneal cavity in some peritoneal catastrophes, such as perforation of a gastric ulcer, may be so slight as to fail in yielding percussion-signs, though a gentle thrill may be obtained in either flank by flicking the parietes with the finger. Again, in another common accident, rupture of an extra-uterine gestation, a sign not to my knowledge hitherto described may be regularly found after a few hours. This sign consists in dulness in both flanks, which, on turning the patient to one side or the other, is found to persist, but which, after a few minutes, leaves the elevated flank and increases on the dependent side; the explanation is that the blood, being thick and partly clotted, makes its way across to the dependent side only very slowly.

Where a tumor is manifest to inspection or rendered evident by palpation, percussion is useful in eliciting the presence of a hollow viscus crossing it, as in the case of the colon crossing a tumor of the kidney, or the stomach lying in front of a tumor of the pancreas.

It must, however, be borne in mind that a palpable and visible tumor may be resonant, as in the case of a volvulus of the intestine, or of an ovarian cyst in which decomposition has given rise to the formation of gas. Abnormal resonance in an area that should be dull is of great significance at times; for instance, in rupture of a hollow viscus, whether from accident or disease, free gas in the peritoneal cavity abolishes liver-dulness by allowing the liver to fall away from the parietes and permitting gas to pass between it and the diaphragm.

In a case of ruptured extra-uterine gestation related to me by my colleague, Mr. Jessop, the liver-dulness disappeared, rendering the diagnosis between that catastrophe and the perforation of a gastric ulcer questionable, the diagnosis being further obscured by the fact that before the rupture occurred there was pain after taking food. The explanation of the disappearance of liver-dulness in this case was probably both dependent on diminution of the liver from the great loss of blood, and distention of the abdomen by the blood in the peritoneal cavity pushing the colon upward and pressing the contracted liver under cover of the diaphragm.

In external hernia percussion often enables a diagnosis to be made between enterocele and epiplocele.

Auscultation is much less important than in the diagnosis of chest conditions; but in the case of doubtful pregnancy it is of great value in eliciting the sound of the fetal heart and of the placental bruit. The phonendoscope and the binaural stethoscope add materially to the resources of the surgeon in this method of diagnosis. For the mapping out of organs and for the elucidation of the site of an intestinal obstruction, auscultation is given a first place in diagnosis by some observers; but the other means at our disposal are in my opinion more efficient and more reliable.

In chronic obstruction the seat may sometimes be determined

by noting the point where a gurgling is loudest and most persistent.

In abdominal aneurysm auscultation often gives valuable assistance when combined with palpation; though alone it could not be relied on, as similar systolic murmurs are frequently observed in sarcomatous or even in fibrous or other solid tumors resting on the aorta.

Friction sounds in peritonitis, splashing sounds in gastric dilatation, and gurgling or metallic sounds in subphrenic abscess containing gas are aids in diagnosis furnished by auscultation.

In the diagnosing of stricture of the esophagus, the gurgling sound produced on fluid reaching the stomach is usually delayed several seconds in the presence of stricture. Esophageal auscultation is elicited by placing a finger over the "pomum Adami" and a stethoscope between the scapulæ, and telling the patient to swallow. The time is noted between the lifting of the larynx and the gurgle caused by the passage of fluid.

Pain.—Though pain may be absent in some few examples, it is present at some stage of the disease in the greater number of abdominal affections, and its character and course frequently afford the most valuable means at the disposal of the surgeon for interpreting and diagnosing ailments which present few physical signs.

The history of the onset of pain may show the local origin of a more general trouble; for instance, in the diffused pain of general peritonitis, it is of the utmost importance to know where the pain was first felt and if a like pain was ever experienced before.

If the pain begins over the cecum or at the umbilicus, it is not unlikely that the trouble has started in the appendix vermiformis; and if there is well-marked tenderness at some point between the right anterior superior spine and the umbilicus, the diagnosis will be rendered much more probable; but if with these signs there is a history of several similar attacks in which the pain was limited to the cecal region and subsided after rest and treatment, the diagnosis of recurrent appendicitis ending in general peritonitis will be rendered almost certain.

If, however, the history of the onset of pain is referred to the right side of the upper abdominal region beneath the right costal margin, and the patient describes having had previous attacks of pain in that situation passing backward to the right infrascapular region, and especially if some of these seizures have been followed by jaundice more or less severe, the diagnosis of peritonitis starting in the gall-bladder will be rendered clear, and the cause may be dependent on a gall-stone that has ulcerated its way from the gall-bladder or -ducts into the peritoneal cavity, or possibly on a phlegmonous or gangrenous cholecystitis.

In general peritonitis starting from perforated gastric ulcer, the pain, though ultimately diffused, will have been first felt over the upper abdominal region, and the history will point to pain after food and probably to dyspepsia of long standing; though in one case of perforated gastric ulcer on which I operated successfully, there was an entire absence of gastralgia for some months before the perforation.

Where the origin of the peritonitis is in the pelvis, the onset will usually be referred to the lower abdominal region, right or left according to the side affected. If starting in the ovaries, the pain will be referred

to the front and inner side of the thigh as well as to the corresponding side of the lower abdominal region ; if starting in the uterus, the pain will be referred to the middle of the lower abdominal region and to the lower lumbar and upper sacral region ; if beginning in the vesiculæ seminales, perineal as well as lower sacral and abdominal pain will be complained of.

In localized peritonitis the pain is usually referred to the region affected, and remains there, radiating, however, in certain well-defined directions according to the organ involved. For instance, gall-bladder pain radiates from the right costal margin toward the umbilicus and backward toward the right infrascapular region ; stomach pain usually radiates from the upper abdominal backward to the left infrascapular region ; but in a number of cases of pyloric disease with adhesions to the liver and gall-bladder, I have noted right infracostal and infrascapular pain, just as in some cases of cholelithiasis with pyloric adhesions, but without other stomach disease, left infrascapular pain has been a distinct feature.

Right or left kidney pain passes from the loin and right or left abdominal region along the course of the corresponding genitocrural nerve. In one case I found left shoulder-tip pain associated with malignant disease of the corresponding kidney, this being probably due to the presence of twigs of the left phrenic nerve in the corresponding semilunar ganglion, which sends branches along the left renal artery.

In disease of the liver the characteristic right shoulder-tip pain is well known, but with it there will usually be well-marked pain or tenderness over the liver itself.

The pain of ovaritis and salpingitis usually follows the course of the corresponding genitocrural nerve ; but there are also pain and tenderness over the right or left side of the inferior abdominal and sometimes in the inframammary region.

In intestinal disease the pain is often referred to the back as well as to the abdomen, and the position of the dorsal pain is usually higher the nearer to the stomach the disease is situated, the range being from the sacral region in rectal disease to the lower dorsal regions in affections of the small intestine. The explanation of this lies in the connection between the sympathetic nerves that pass along the blood-vessels of the affected part and the corresponding spinal nerves.

One example will suffice to explain this : In appendicitis, although the disease is in the cecal region, the first pain complained of is nearly always at or just above the umbilicus. The reason for this is that the appendix receives its blood-supply from the superior mesenteric artery, and the nerves that accompany the branches of this vessel communicate with the spinal nerves at a higher level than those which supply the descending colon and the sigmoid flexure. The reflected pain comes along the tenth and eleventh dorsal nerves to the umbilical region.

The character of the pain is equally important with the site ; colicky pain is usually relieved, whereas inflammatory pain is intensified, by pressure ; and while the former pain is usually intermittent, the latter is continuous. Localized colicky pain of irregular onset, often at long intervals, is usually due to gall-stones, to calculus of the kidney, or to

appendicitis, the painful attacks being associated in each case with symptoms referable to the liver, the kidney, or the bowels, thus in well-marked cases rendering the diagnosis easy; but in the slighter cases the course of the pain may be the only means of enabling a diagnosis to be arrived at.
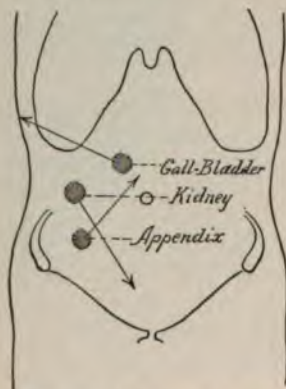
FIG. 172.—Diagram showing seat of pain in cholelithiasis, in appendicitis, and in renal disease.

The accompanying diagram (Fig. 172) shows the tender spot characteristic of each disease; but besides the tender spot, the course of the pain toward the right infra-scapular region in cholelithiasis, toward the umbilicus in appendicitis, and along the genitocrural nerve in renal disease, is of great diagnostic importance. The direction of the pain is shown by the arrows in Fig. 172.

Neuralgic or neurotic pains are irregular and indefinite, often lasting for long periods and then disappearing without apparent cause; they are frequently periodical, as in the case of other neuralgiæ, and they fluctuate with the state of the general health. We should not forget, however, that many so-called visceral neuroses are merely a cloak for ignorance, and that the pain is caused by something too subtle for our diagnosis. Thus, visceral adhesions are a fertile source of discomfort and disability. I have been fortunate in being able to relieve or cure many cases of most distressing abdominal affections, said to be neurotic, by detaching adhesions of the pylorus to the liver or gall-bladder, of the ovaries and tubes to the rectum or other part of the intestinal canal, of the sigmoid flexure to glands at the pelvic brim, and of small intestine to old caseated or calcareous glands at the back of the abdomen. Again, stricture or kink of the pylorus or of the intestine, not sufficient to cause obstruction, but marked enough to produce distress, should not be forgotten in diagnosing the cause of obscure abdominal pain. Formerly many cases of gall-stones or renal calculi which produced pain without other physical sign were described as neuroses, as were slight cases of recurrent appendicitis and cases of salpingitis or of ovaritis, all of which are now easily recognized and capable of cure.

It is worth bearing in mind that, though intermittent pain occurring at the same hour daily or nightly is usually neuralgic, it may be dependent on organic disease; for instance, in an obscure case of malignant disease at the back of the abdomen, the intermittency of the pain was so marked as to mislead for a time; and even after the diagnosis had been made and up to the end of the case this intermittent character of the pain persisted.

Measurements of the abdomen afford some little help in diagnosis; but they are chiefly of assistance in recording cases and in estimating the progress of disease. The tape-measure is the most useful, as it adapts itself easily to the surface.

We estimate the varying degrees of abdominal distention by taking the circumference of the abdomen at the umbilicus and at 3 inches

above and below. We compare the relative distention of the two sides by measuring from the spine to the umbilicus, and from the umbilicus to the anterior superior iliac spine on either side.

In an ovarian tumor the amount of distention of the two sides usually varies in an early stage; but later this irregularity may disappear as the abdomen becomes more distended.

In myoma uteri and in pregnancy the two sides are usually symmetrical.

In tumor springing from the pelvis the circumference is usually greater below the umbilicus; in ascites it may be equal above and below.

The surgeon, however, should not rely too much on measurements in making his diagnosis, as other and better means are at his disposal.

The **pulse, temperature,** and **respiration** should all be taken into consideration in deciding on any abdominal case, since they give valuable information as regards the general condition; and, if operation is contemplated, as to the fitness or otherwise of the patient to bear it.

In the course of convalescence after operation, it is of importance to watch carefully the pulse, respiration, and temperature. A sudden increase in the number of respirations may point to chest-trouble developing, or it may be dependent on distention due to flatus collecting in the stomach and bowels.

An increase of temperature may indicate inflammation, and an increase of pulse-rate may indicate exhaustion or peritonitis.

I am accustomed to rely on the pulse much more than on the temperature in the prognosis of abdominal cases after operation; a quick pulse with a normal or subnormal temperature being of more serious significance than a quick pulse with an elevation of temperature. An increase of temperature alone is of little moment, if the pulse is not increased out of proportion.

In appendicitis the condition of the pulse affords important diagnostic assistance. If it is slow or only slightly accelerated, with very few exceptions the disease is limited and resolution may occur; but if the pulse becomes quickened early in the case, or in fact at any stage, the question of operation will have to be considered.

The very rapid pulse of peritonitis, the dicrotic compressible pulse of typhoid, the sudden failure of pulse in collapse from hemorrhage, are well known and always demand attention.

The shallow, rapid, costal breathing from pain at the commencement of peritonitis, and from distention in the later stages, are very noticeable, just as are the sighing respiration in internal hemorrhage and the jerky, catching breathing in diaphragmatic peritonitis or subphrenic abscess.

An elevation of temperature is usually an indication for increased vigilance. If post-operative, it need cause no anxiety should a moderate rise occur within the first forty-eight hours, as it may be simply traumatic fever, either nervous or dependent on absorption of aseptic wound-exudation; but if the temperature keeps up beyond the second day, it is usually an indication of some local inflammatory disturbance.

An elevation of temperature, after it has been normal for several days, may occur from stitch-abscess; hence in such a case the wound

should be carefully examined; or it may be that a collection of inflammatory fluid may be forming within the abdomen and require evacuation and drainage. If the rise is sudden and accompanied by a rigor, and nothing is found locally to account for it, the chest should be examined, as there may be pneumonia or pleurisy.

In the diagnosis of abdominal diseases generally, fever is a very variable symptom; but on the whole it may be taken to indicate some inflammatory affection; and, if there are rigors, the formation of pus, though pus may form in the abdomen without rigors and even without fever.

Intermittent fever in the presence of jaundice points to infective cholangitis and usually to gall-stones; this will aid in the diagnosis between gall-stones and malignant disease.

FIG. 173.—Robson's clinical chart.

In enlargement of the liver, rigors with irregular temperature may point to some infective condition, such as suppurative cholangitis, pylephlebitis, or hepatic abscess; in the first two named conditions the fever is irregular—in fact, pyemic in type, whereas in hepatic abscess the chart will probably show a more even line. In liver-abscess the temperature is often misleading, the fever being sometimes very little marked, at others hectic in character, and at others resembling ague.

In order to compare the pulse, temperature, and respiration, and to estimate their proper relationship to one another, I always employ the chart shown in Fig. 173, which I have found of great assistance.

Inflation by means of hydrogen or carbonic acid gas as an aid to

diagnosis was suggested by Ziemssen in 1883, and later by Minkowski; but it was brought more prominently to the front by Senn, who showed how it might be employed for the purpose of diagnosing perforation of the viscera, especially in bullet wounds of the abdomen.

Though ingenious and at times useful, this method of inflation in abdominal injuries has never found much favor, since it has been discovered that on distending the hollow viscera their contents are apt to be forced into the peritoneal cavity, thus rendering the operation that has to follow less likely to succeed from the increased danger of septicity. Moreover, the distention of the intestines adds to the difficulty of operating, since it is much more easy to manipulate and repair the hollow viscera when collapsed.

As a routine method of diagnosis inflation is little practised, since it is seldom absolutely necessary; but occasionally it may be of great service in clearing up a difficult diagnosis. For instance, dilatation of the stomach may be readily demonstrated either by causing the patient to swallow a solution of sodium carbonate and afterward one of tartaric acid, thus liberating free carbonic acid in the gastric cavity, or by injecting carbonic acid or hydrogen through a stomach-tube. Should there be any difficulty in diagnosing between the splash of a dilated colon and that of a dilated stomach, this method would completely resolve the doubt.

Sometimes it may be difficult to diagnose between a tumor of the right kidney and one of the gall-bladder; but distention of the colon, as a rule, settles the doubt by pushing the kidney back to the loin and the gall-bladder up toward the ribs.

In one case of this kind, however, which came under my care, Ziemssen's test actually obscured the diagnosis, as the tumor was pushed upward on distending the colon, thus leading me to think I had to deal with the gall-bladder, when on abdominal section I found the disease to be a sarcoma of the right suprarenal body, which, passing over the upper border of the hepatic flexure of the colon, was pushed upward on inflation.

In tumor of the pancreas a difficulty may arise in the diagnosis between it and a growth of the stomach; but inflation of the stomach at once shows the relationship of the two. Many other examples might be cited to show how inflation or even distention with fluid may be useful in the diagnosis of intestinal and other tumors; but it can only be in very exceptional cases that the method will be called for, and in the greater number of cases its employment is superfluous.

Anesthesia in aiding palpation is at times most valuable—in fact, in certain pelvic and other cases a diagnosis is impossible without its aid. In painful pelvic conditions, especially in stout women, a bimanual examination is frequently impracticable without the aid of an anesthetic; whereas when the patient is fully relaxed, the whole of the pelvic contents can be examined with one hand on the abdomen and a finger of the other hand in the vagina or rectum. Small ovarian or uterine tumors, adhesions of the appendages, flexion of the uterus, growths of the upper part of the rectum or sigmoid flexure, and other abnormal conditions can then be accurately made out.

In the case of phantom tumors the administration of an anesthetic

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at once clears up the case. In a well-marked example of this kind I was able to demonstrate to a class of students the disappearance of a phantom tumor directly the patient became unconscious, and its reappearance the moment consciousness returned; and yet the woman herself could not be convinced that the tumor was a spurious one, and she could give us no explanation of how it was produced. The existence of a hysterical tympanites or of a dilated colon may be determined by the use of an anesthetic.

In the case of a doubtful tumor of the pylorus or gall-bladder, especially if associated with marked tenderness or local peritonitis, a rigid right rectus renders successful palpation almost or perhaps quite impracticable, whereas a few moments' relaxation by means of an anesthetic enables an exact examination to be made.

Where it is necessary to make a careful pelvic examination in a virgin, the use of an anesthetic removes much of the difficulty of the situation, especially as a complete bimanual examination can be made by means of the finger in the rectum, instead of in the vagina. The same applies in children, in whom, under an anesthetic, nearly the whole of the abdomen may be explored by the finger in the rectum and the other hand on the abdomen. In this way a horseshoe kidney may be made out, retroperitoneal glands can be felt if enlarged, tubercular nodules in the peritoneum or in the pelvis can be discovered, and many other ailments otherwise difficult of diagnosis may be accurately defined.

Instrumental Aids to Diagnosis.—The Uterine Sound.—This much-abused instrument has certain uses in diagnosis; but the bimanual method of examination renders its employment for measuring the size of the uterus or ascertaining the position of the fundus seldom necessary.

In certain cases of appendage-disease in which the abdomen is too tender to permit of an effectual bimanual examination, and in the case of other small tumors in Douglas's pouch, the question as to whether the swelling is dependent on a retroflexed uterus or on something else, can immediately be set at rest by passing the sound.

In some cases of abdominal tumor the sound is of use in ascertaining the relation of the uterus to the tumor, and of estimating the size of the cavity of the womb. If the cavity is not enlarged, the probability is that the tumor is ovarian, or at all events not uterine; whereas if the cavity is markedly elongated, the chances are in favor of the tumor being uterine.

The condition of the interior of the uterus may often be told by the sensation conveyed to the touch, as in the roughened, hard, craggy feel of cancer. The effect of touching the parts with a sound may in itself be diagnostic, as in the free bleeding following on sounding the uterus in the case of a soft malignant growth, or even in some cases of fungous endometritis.

It should, however, be borne in mind that, though occasionally useful, the uterine sound is only to be employed where absolutely necessary, and then it should be thoroughly asepticized before being used, and on no account should force be employed; moreover, if a period has been missed, or there is any question of pregnancy, its employment is, of course, out of the question.

The **exploring-syringe** is rarely used by those most experienced in abdominal work; in the first place, because its employment is seldom necessary in diagnosis; in the next place, because, even if it enables a more exact diagnosis to be made, it usually does not modify treatment; and, lastly, because its use is not unattended by danger.

There have been recorded by various writers quite a number of cases in which death has followed the use of the exploring-needle; and it is easy to see why this should be so in the case of tense cysts, as the puncture-aperture may continue to leak into the peritoneal cavity long after the needle has been withdrawn.

Among my early experiences I obtained several lessons from the employment of an exploring-syringe. In one case I explored a distended gall-bladder immediately before performing abdominal section, and within five minutes I had the opportunity of seeing the small needle-puncture pouring out a stream of mucopus directly into the peritoneal cavity. I was fortunately able to clear it all away, and so to prevent ill-effects; but had I not been immediately operating, in all probability septic and possibly fatal peritonitis would have supervened. In another case of dermoid ovarian cyst explored under similar circumstances, on opening the abdomen I found the intestines covered with liquid fat and short hairs, which I had the greatest difficulty in wiping and washing away; and although no ill-effects followed, it was certainly because of operation immediately following the puncture. I could relate other examples; but these will suffice to show that where further light is needed, it is, as a rule, much safer to obtain it by exploration through a small incision than by means of even the small needle of an exploring-syringe. Even in a case of ascites, although a clean exploring-syringe will do no harm, a small incision will answer infinitely better, in that at the same time the cause can be discovered, the fluid let out, and, if thought needful, drainage can be adopted.

Moreover, another danger of the exploring-syringe—sepsis—must not be overlooked, as it has not infrequently followed its use; and when it is borne in mind that the instrument is rarely employed by experienced surgeons, but usually by those less experienced in surgical procedure, the occasional occurrence of septic complication following on exploration is not to be wondered at. If employed, the needle should be boiled and the skin thoroughly asepticized before the operation is performed.

The **aspirator,** with proper precaution as to boiling the needle and asepticizing the skin, is much safer than the simple exploring-syringe, since in the case of a tense cyst the contents can be evacuated and the tendency to leakage reduced to a minimum. Occasionally, also, the aspiration of a tense cyst may tide a patient over a critical period and enable a better time, or perhaps a better place, to be selected for the major operation that has to follow.

What information does such an exploration afford? It usually differentiates a solid tumor from one with fluid contents, unless the contents of a cyst be too thick to flow through a hollow needle, as indeed is frequently the case in multilocular ovarian tumors that convey no sense of fluctuation to palpation; in such a case little or no help will have been derived from the procedure.

Should there be a doubt between pregnancy and fibrocystic tumor of the uterus or other tumor of pelvic origin, it is easy to differentiate amniotic from any pathological fluid. I once saw an operating surgeon of experience saved from a serious mistake in a case of hydramnios by the use of an exploring-syringe just before operation, which, needless to say, was not proceeded with.

The mucous fluid from a distended gall-bladder, the mucopus from an empyema of the gall-bladder, the clear watery fluid from a hydatid cyst, the usually grumous fluid from a pancreatic cyst, the straw-colored fluid of ascites, the colloid fluid from an ovarian cyst, the clear fluid of a parovarian cyst, and the urinary fluid from a renal cyst are all characteristic, should it be thought necessary in any such cases to make a preliminary exploratory puncture.

In the case of subphrenic abscess and in abscess of the liver the exploring-syringe or aspirator affords useful aid both in diagnosing the presence of pus and in enabling the surgeon to decide on the site of operation. On the other hand, it has been distinctly proved that in perityphlitis or appendicitis an exploratory puncture is neither necessary nor desirable, and that its employment is attended with danger.

The " **rectal balls** " are occasionally useful in locating a stricture of the upper part of the rectum or lower end of the sigmoid, or even in giving exact information as to the caliber of the stricture; but it should be borne in mind that the inability to pass a rectal ball is no proof of stricture, as it may be caught in one of Houston's folds. If, however, a full-sized rectal ball passes into the sigmoid flexure, it proves the absence of stricture, and thus may give valuable information in cases of intestinal obstruction.

A preliminary slight distention of the lower bowel with olive oil will at times flatten out the folds and facilitate the passage of the balls. It must never be forgotten that on no account must force be used, since, just as in the employment of the long tube, perforation of the bowel-wall has occurred, so in the use of the rectal balls, especially the smaller sizes, serious injury may be inflicted by forcible manipulation.

Esophageal bougies are employed in cases of dysphagia not only for treatment, but for diagnostic purposes, when the question of gastrostomy arises, to ascertain the site of obstruction and its nature. I prefer instruments made after the pattern of "bougies a boule" employed in urethral cases; they are not generally known, but in my opinion they present great advantage both in the ease and safety with which they can be utilized, and the facility with which they can be employed to dilate a stricture. Messrs. Rausche of Leeds made my first set some years ago, and they have since copied them for other surgeons.

In case of starvation from stricture of the esophagus the question of gastrostomy has to be considered; but it must first be shown that the disease is incapable of being overcome by other means. Cases of simple stricture are very rare, and such may usually be efficiently treated by dilatation. Cancerous strictures, on the other hand, cannot be safely dilated, and will require other treatment. If there is a history of steady loss of flesh and gradually increasing dysphagia in a middle-aged or elderly patient, malignant stricture will be suspected; and if

on passing a bougie it is arrested just before entering the stomach, the diagnosis is rendered very probable; but if there is slight bleeding caused by the bougie when gently used, little doubt will be left.

Spasm is more frequent in the pharynx, though it may occur in any part of the esophagus. It usually occurs in younger subjects than are afflicted by malignant stricture, and nearly always in women. It is, moreover, frequently associated with other nervous symptoms, varies in intensity, and usually yields to the passage of bougies without difficulty. If, however, a bougie cannot be passed in a case where spasm is suspected, an anesthetic will at once settle the doubt, as under its influence a full-sized bougie readily reaches the stomach when the stricture is due to spasm alone.

Electric illumination has not done much as yet for diagnosis in abdominal diseases, except in the case of the bladder and kidneys, where the endoscope has proved of inestimable service in the diagnosis of tumors and of other diseased states of the urinary apparatus. In estimating the work done by a diseased kidney and settling positively the discharge of pus from one or the other kidney, the examination of the ureteral orifices in the bladder has proved useful.

In stomach surgery the gastric endoscope has as yet not proved itself of any material service.

The **Röntgen rays** have been employed on numerous occasions as an aid to diagnosis in abdominal disease, and in some cases with decided advantage. In gall-bladder surgery they are useless, as cholesterin transmits the rays as readily as do the soft tissues; though doubtless those calculi containing some lime in their composition would make an impression on the screen.

On several occasions after cholecystenterostomy by means of the Murphy button, the button has not come away, and its position has been shown by the Röntgen rays. Skiagraphy has also been of use in some of the cases of intestinal or stomach surgery in which a large Murphy button has been employed, and, not having passed, has produced obstruction, as by means of the X-rays the metallic button can be easily demonstrated.

In 2 cases of swallowed coins I was able to demonstrate their presence in the esophagus, and afterward to remove them. Coins and other metallic bodies can be shown in the stomach, whence, if producing discomfort or illness, they can be removed by gastrotomy.

In renal surgery the Röntgen rays have been disappointing, as, owing to the thickness of the tissues in the loins, renal calculi can seldom be demonstrated. I have tried them in several cases without effect; and in 1 case their failure was very manifest, as after a fairly good skiagraph had been taken, showing no sign of stone, I removed one the size of a filbert from the photographed kidney. In some few cases in thin subjects the photographs have revealed calculi.

The suggestion of Mr. Hurry Fenwick, to use the screen and the Röntgen rays when the kidney is brought out of the lumbar wound, is worth bearing in mind in those rare cases in which, under the circumstances, the finger or the sound cannot detect a stone. Where there is a question between pregnancy and some other pelvic or abdominal tumor, and where other means of diagnosis have failed to make the

case clear, the *X*-rays would be capable of showing the fetal bones; and in those rare cases of lithopedion, the diagnosis of which is often difficult, skiagraphy might prove decidedly useful.

Exploratory Incision.—In only a very small percentage of cases is simple exploratory incision as a means of diagnosis necessary or even justifiable; and there can be no doubt that in some cases it has served as a cloak for carelessness or incompetence.

A careful physical examination, and time and care in studying the history of the case, will usually enable either an exact diagnosis to be made or an approximate one to be arrived at; and in the odd case the experienced surgeon can usually say that the case is one likely only to be relieved by surgical treatment, though possibly the exact pathological condition may be a matter of some doubt. Where there is doubt, and delay will not be injurious, a second or even a third examination should be made, as it is well known that at a second visit new facts may be brought to light, the patient's memory is stirred up, and small data, really important, but thought by the patient or friends too trivial to mention at the first visit, may form the key to the situation. Moreover, the mind of the surgeon may on the next visit focus his attention on different points or group his data differently, and so perhaps arrive at a truer conclusion.

In case of doubt, the surgeon, if he has not already had the advantage of the opinion of a medical colleague, should avail himself of the opinion of a physician who will be able to look at the case from a non-operative point of view. It must not be forgotten, however, that the surgeon must bear the responsibility that awaits the decision, and he should be careful, if a positive diagnosis cannot be arrived at and operation is decided on, to be able to answer two questions in the affirmative:

First, Can I perform an exploratory operation without adding serious risk to the life of the patient, already threatened by the disease?

Second, Is it possible that good will result from the exploration?

For instance, in certain cases of intestinal obstruction an exact diagnosis of the cause is frequently impossible; but if other means of treatment have failed, it would be almost criminal for the surgeon in such cases to stand idly by and decline to make an exploratory incision, simply because no diagnosis had been arrived at. Rather he should open the abdomen in order to make a more accurate diagnosis, and, if practicable, to remove the cause of the obstruction; or, failing that, he can bring a distended loop of bowel to the surface and drain it, leaving the cause to be dealt with when the patient has recovered from the acute condition.

At times the surgeon may be called on to explore the abdomen for an abdominal tumor the nature of which is doubtful—possibly a solid tumor under cover of the intestines. Under such circumstances, when the tumor is exposed, the great gift (usually a matter of common sense combined with experience) of " knowing when to stop " comes in; for while an exploratory incision made with due precautions will involve no risk to the patient, any interference with the tumor—if, say, a retroperitoneal sarcoma or a malignant tumor of the ovary or of the gut or of the gall-bladder with adhesions to surrounding parts—may inflict such

injury on the growth or start such an uncontrollable hemorrhage that the surgeon is compelled to convert his harmless exploratory procedure into one of the most serious operations, which, if it does not cause death on the table or shortly after, can lead to no ultimate good. This is sheer meddlesomeness, and for the credit of surgery, if from no higher motive, should be avoided.

The curative effects of abdominal section *per se* when undertaken as a simple exploratory procedure cannot be dwelt on in this chapter; but the fact should be borne in mind that in some well-authenticated cases, after a simple exploratory incision, in which a solid fixed tumor has been found and thought to be malignant and irremovable, complete and permanent recovery has taken place and the tumor has entirely disappeared. In some of these cases, doubtless the tumor has been inflammatory, and in others tubercular; but in quite a number the growth has apparently been malignant. No satisfactory explanation of these cases has as yet been given, but they are worth bearing in mind when exploratory operation is advocated.

Examination of Discharges. — Vomited Matters and the Contents of the Stomach.—With regard to vomit, the first thing to consider is the quantity vomited at one time. Nurses should be trained to estimate this carefully and also to preserve specimens on all occasions.

In dilated stomach vomiting occurs not more often than once or twice a day, and sometimes only every second or third day, and the quantity at one time is correspondingly large.

In ulcer of the stomach a considerable portion of the last meal is brought up within an hour or two of its ingestion, and the pain it has caused is thereby relieved.

In intestinal obstruction and in peritonitis the quantity brought up is very variable, and often there is retching. The act is a violent one, and is not necessarily related to the taking of food.

The smell should be considered: a yeasty smell is characteristic of dilated stomach; an habitual fetid odor, of cancer of the body of the stomach; a feculent odor, of intestinal obstruction. In this last condition masses of feces are sometimes vomited, this being a very grave sign. A few cases of spontaneous recovery even from this are, however, on record.

Vomit is usually acid in reaction; but it may be alkaline in some cases of chronic dyspepsia and when there is much blood present.

Bile is frequently present in vomit, and usually colors it dark green. It generally indicates that the act of vomiting has been performed violently or on an empty stomach. If any test beyond the characteristic appearance be required, Gmélin's test with fuming nitric acid is employed.

The most important abnormal constituent of vomit is blood. In large quantities its nature is obvious, and the event is usually characteristic of simple ulcer; but in cirrhosis of the liver profuse hematemesis may occur, owing to rupture of dilated veins. In smaller quantities the vomit has a characteristic dark appearance resembling "coffee-grounds."

When the existence of blood in vomit is doubtful the most reliable

guide is the hemin-test. Some of the material is filtered and the filtrate evaporated to dryness. Powder the residue and place a little on a glass slide. Add a drop of glacial acetic acid and heat gently. Cover with a cover-glass and examine under a high power for small dark-brown crystals of hemin. A crystal of common salt is not necessary here, as there are chlorids present.

In cancer of the stomach blood is frequently present in the vomit, often in small, sometimes in considerable, but rarely in large quantity.

It must not be forgotten that hematemesis is a symptom of cirrhosis of the liver and of advanced valvular disease of the heart.

In the so-called "black vomit" of acute peritonitis black fluid is poured out in large quantity, which on examination is found to consist of altered blood and bile; it is a most unfavorable sign, and such cases usually end fatally.

Pus is sometimes, but rarely, vomited. In considering both pus and blood in a fluid said to be vomited, it must be remembered that when large quantities of fluid are expelled from the lungs (e. g., on the rupture of an empyema into the lung or in severe hemoptysis) the sensation to the patient is often as if vomiting had occurred. The presence of food and the absence of frothiness will help to distinguish true vomit, while vomited blood is generally much darker than blood from the lungs. But the only reliable way is to inquire carefully into the facts of the occurrence.

Pus in the vomit may arise from an empyema of the gall-bladder or a pancreatic abscess or some other abscess bursting into the stomach or esophagus.

Examination by the microscope is of secondary importance. In dilatation of the stomach the sarcina ventriculi is frequently to be seen, together with yeast-cells.

In reference to the diagnosis of malignant disease of the stomach, the relative abundance or absence of free hydrochloric acid has been pointed out as of importance by Ewald. The patient takes a "test-breakfast," consisting of a cup of weak tea and a little dry toast. An hour later the stomach-tube is passed and the contents of the stomach drawn off. These are tested for free hydrochloric acid by Gunsberg's test. The reagent consists of 2 parts of phloroglucin and 1 part of vanillin in 30 parts of absolute alcohol. Some of the filtered contents of the stomach are evaporated to dryness in a porcelain dish. A drop of the reagent is added; a delicate red-rose tint shows the presence of free hydrochloric acid.

The absence or deficiency of free hydrochloric acid occurs in several morbid states; but its presence is a strong point against a diagnosis of malignant disease of the stomach.

Examination of the Feces.—The normal color of the feces is due to the bile. In obstruction of the hepatic or common bile-duct the feces are white. Thus, the color of the feces after operations on the gall-bladder and bile-ducts indicates the patency or otherwise of these ducts. It has been observed, however, after operations in cases of long-standing jaundice, that the stools have remained white, although the ducts were free. This has proved to be due to an almost complete absence of bile-pigment from the biliary secretion.

In some cases of pancreatic disease the motions are almost white, although containing some bile.

Persistent jaundice with very light-colored stools, if associated with a tumor of the gall-bladder, frequently indicates cancer of the head of the pancreas.

If red blood is present in the motions, it has come from the colon or rectum, and in the latter case is usually from piles.

A dark or black color of the feces, " tarry motions," indicates considerable hemorrhage higher up in the alimentary canal, and is usually a sign of ulceration or growth.

As iron and bismuth color the stools dark, their ingestion must be excluded before making a diagnosis ; but the tarry appearance is usually quite characteristic of altered blood.

The feces are sometimes altered in shape. When there is stricture below the level of the sigmoid the feces are often pipe- or ribbon-shaped. This appearance may, however, be produced by spasmodic contraction of the external sphincter ani during defecation, as in some cases of fissure of the anus.

When gall-stones or mucous casts are to be looked for, the feces must be carefully washed through a muslin sieve.

Mucous casts of the bowel indicate colitis, as also do flakes of lymph and small quantities of pus and red blood.

In membranous colitis the attacks of pain at times resemble gall-stone seizures; hence in the less-marked cases of cholelithiasis it is important to negative colitis before concluding a diagnosis. Blood and mucus are also present in intussusception. Pus in any quantity is usually obvious. When there is any doubt the microscope will settle it. Its presence indicates rupture of an abscess into the alimentary canal at any part of its course below the stomach. It may also come from a fistula or cancerous ulcer of the lower bowel.

The presence of large quantities of fat manifest to the naked eye forms part of Addison's classical description of pancreatic disease. This is a very rare condition, and is by no means always present in disease of the pancreas, though an abundance of small particles of fat on close inspection and of fat-globules under the microscope is usually found. Such small particles of fat may be distinguished from mucus or lymph by their solubility in ether.

The clay-colored stools of obstructive jaundice also contain much fat, and it occurs in not a few other conditions.

Examination of the Urine.—It is useful, as far as possible, to have a record of the *quantity* passed in the twenty-four hours.

An attack of polyuria lasting a few hours, occurring as a unique event or at considerable intervals of time, may indicate a hydronephrosis, and in such cases the kidneys should be examined to ascertain the presence of enlargement or excessive mobility. In rare cases such an event has been due to rupture of an ovarian or parovarian cyst with a consequent rapid absorption and excretion of fluid. In intestinal obstruction the quantity of urine passed is diminished. This is more marked the higher up the alimentary canal the obstruction takes place ; and when that is near the stomach little or no urine is passed.

The *color* of the urine is important. In obstructive jaundice bile

appears in the urine before it stains the skin; while on the relief of the obstruction it disappears from the urine long before the staining of the skin fades.

When highly jaundiced the urine is dark brown, green, or black. In slight cases there is merely a greenish sheen, seen much better by reflected than by transmitted light.

Bile may be present, although not visible to the naked eye, and some of its aspects may be imitated by drugs, though the difference in reflected and transmitted light is fairly characteristic. It is well, therefore, in any such case to confirm the diagnosis by the usual tests for bile-pigment and bile-salts.

Blood in the urine renders it pink or bright red, if present as hemoglobin. Often it is present as some derivative, generally methemoglobin or hematin, and then the urine has a smoky-brown or black color, according to the quantity present.

As some of these appearances may be imitated by drugs and in other ways, it is often necessary to confirm by appropriate tests.

The old-fashioned guaiac and ozonic ether test, though condemned by refined chemists, is generally adequate for these examinations if the influence of drugs, especially potassium iodid, is excluded. A drop of tincture of guaiacum is mixed with a small quantity of ozonic ether, a few drops of the urine are added and the fluids are mixed. A blue color indicates the presence of blood. When small in quantity the reaction may be delayed for five or ten minutes.

If there is any doubt, the corpuscles should be sought for under the microscope. But the most delicate test, and the one to be relied on if the corpuscles are absent or cannot be found, is the demonstration by the spectroscope, either of the double oxyhemoglobin-bands between D and E, or of a single band on the red side of D, due to methemoglobin or alkaline hematin.

When hematuria occurs in an abdominal case the most important conditions to differentiate are renal calculus, tubercular and malignant disease of the kidneys and bladder, and papilloma of the bladder.

Vesical disease is excluded by absence of marked frequency of micturition, pain after the act, and by an acid or undecomposed urine; while, if necessary, actual examination with the cystoscope may be employed.

In renal calculus the attacks of hematuria, associated at times with small quantities of pus and albumin in the urine, occur at intervals, often after great exertion, and are associated with renal pain and often with pyrexia. During the intervals there is a complete or partial subsidence of symptoms and the urine becomes nearly or quite normal.

Both tubercular and malignant diseases of the kidney are associated with renal tumor. In tubercular disease there are sooner or later an intermittent pyrexia and night-sweats. The hematuria is probably not so profuse as in malignant disease; and if it is profuse, there are considerable intervals of moderate hematuria. There is usually pus, often in considerable quantity, in the sediment; while in malignant disease the pus is in much smaller ratio to the blood. Finally, tubercle bacilli are found in the sediment. The search for these must be careful and systematic. Several cover-glasses should be prepared from each

specimen of sediment, and if not found at once, the sediment passed on several different days should be examined. It is undeniable that those who are in the habit of frequently making such examinations are more successful than those with whom it is an occasional task. The sediment is collected in vessels with a shelving bottom, or a centrifuge may be employed. The cover-glasses having been prepared in the usual way are then stained by the Fränkel-Gabbett or Ziehl-Nielsen differential method.

Other micro-organisms are frequently found in the urine, usually associated with cystitis, but sometimes with pyelitis; in the former case the urine is usually alkaline, in the latter often acid.

Pyuria has been incidentally considered above; besides the cause there referred to, the rupture of purulent collections into the urinary passages must be considered. In this case, if the character of the urine has been known before, or may safely be presumed to have been normal, we have a more or less sudden access of pus in the urine without any accompanying urinary symptoms; if cystitis can be excluded, the diagnosis will probably be easily made and the source discovered. A pelvic abscess, a suppurating dermoid ovarian cyst, an abscess of the prostate, a collection of pus from diseased bone or glands may burst into the bladder or ureter, and an empyema of the gall-bladder has been known to burst into the pelvis of the right kidney.

A secondary cystitis is liable to ensue, sometimes rapidly; and then the diagnosis will have to be made on other grounds than the examination of the urine.

Albuminuria is chiefly of medical interest. In abdominal tumors it sometimes occurs from passive congestion of the kidneys, due to pressure. This is, however, certainly rare.

When albuminuria occurs in association with pus or blood in the urine, it must not be at once inferred that it is altogether due to the presence of either or both. There may be a considerable deposit of pus and very little albumin in solution; and in the same circumstances it seldom exceeds 0.5 per thousand as estimated in an Eshbach's tube. In all such cases Bright's disease should be excluded by an examination of the general symptoms, and the urine should be examined for tube-casts and renal epithelium.

The most important relation of *glycosuria* to the diseases we are considering is its connection with pancreatic disease. This is a fact which cannot be said to be thoroughly explained yet; it is not necessary to discuss the pathology of it here, but it may be pointed out as of practical moment that glycosuria in association with abdominal disease should lead to a special consideration of the pancreas.

Peptonuria is of importance on account of its association with malignant disease of the digestive tract and with chronic suppuration. If a urine fails to give a precipitate with heat and nitric acid in the cold, but gives one with picric acid or potassiomercuric iodid, the precipitate may be due to peptones, and this will be decided by the biuret reaction.

One other abnormal constituent of the urine—abnormal at least in quantity—is of importance with regard to abdominal disease. This is *indican*. When this is in abundance in the urine, it indicates an excess of putrefactive changes in the intestines, and may thus be taken as a

measure of the toxicity of the intestinal contents.   It is found in intestinal obstruction, enteric fever, etc.

A very interesting case illustrating the diagnostic value of indican in the urine has recently been communicated by Pearce Gould to the Clinical Society of London.[1]   Indican continued to be abundantly present in the urine after an intestinal obstruction had been completely relieved.   The patient died with symptoms of profound toxemia some days later.

The test for indican (indoxyl-sulphuric acid, the potassium salt of which occurs in the urine) depends on the formation therefrom of indigo, by oxidation.

Ten c.c. of urine are added to an equal quantity of strong hydrochloric acid ; 2 or 3 c.c. of chloroform are added, and then a strong solution of chlorid of lime, drop by drop, the mixture being well shaken after each addition.   If indican is present, the chloroform dissolves the indigo formed from it and collects on the top as a blue layer of fluid.

[1] Dec. 10 ; *Brit. Med. Jour.*, Dec. 18, 1897.

CHAPTER X.

PERITONITIS.

PERITONITIS, for all practical and clinical purposes, may be defined as an inflammation of the peritoneum caused by the presence of bacteria and their products. Occasionally one meets with a condition which pathologically resembles an acute peritonitis, but in which the pathogenic germs may not be found. These so-called cases of chemical peritonitis occur in strangulated herniæ and after aseptic celiotomies, where the loops of the intestines are bathed with a bloody serum and have lost the smooth glisten of the normal peritoneum. Such a patient may simulate very closely the picture of an acute infection; but when the absorption of septic material is stopped by simple drainage, the rapid change in condition shows the absence of any progressive lesion. In such a case it is probable either that there has been a previous infection by pathogenic bacteria which have been removed by rapid absorption through the lymph-channels, or that there has taken place a sufficiently toxic exudation from the lumen of the intestine to give rise to the local and general symptoms of a peritonitis, though the actual passage of the bacteria has not taken place.

A good example of such a process can be seen in a mild case of appendicitis. On entering the abdomen, the appendix and the surrounding loops of gut will be found to be congested and covered with a variable amount of fibrinous lymph, but no pus; perhaps a little bloody serum. Cultures from such an exudate show that it is often sterile, and the explanation seems to be that the chemical productions of the active germs in the lumen of this small segment of gut have transuded through the wall and started the wonderful reparative power of the peritoneal surface. Similar lesions in the peritoneum can be seen where chemical changes have taken place; for example, in the interior of an ovarian cyst from twisting of its pedicle. Recently, Wieland has succeeded in producing a true local peritonitis, with the formation of fibrin and pus, by introducing into the abdominal cavity small sterile fish-bladders containing sterilized cultures of the pyogenic cocci. The membrane prevented the too rapid carrying off of the toxic products of the bacterial metabolism, as is the case when the toxins are simply injected, and permitted a gradual absorption, so as to imitate the natural conditions as much as possible. A similar result had been obtained by Prudden several years before, while studying the action on the tissues of dead tubercle bacilli. The tubercles thus obtained could not be distinguished from those produced by living bacteria, showing that the bodies of these dead bacilli contained enough of the specific poison to cause the familiar changes in the cells of the peritoneum and its underlying connective tissues. Another valuable hint contained in these results is that the effects, both general and local, of the bacteria producing the peritoneal inflammation, are largely due to the metabolic products of the germs, and not to their mere mechanical action and growth.

The difference, however, between a chemical and a true bacterial peritonitis is that the former is never progressive—there is a tendency to resorption of the exuded products and a gradual return to a normal condition. The true bacterial peritonitis, on the other hand, shows no tendency to spontaneous cure until the conditions are exactly similar to those existing in the chemical form. In other words, nature's method of healing a localized bacterial infection is, first, to cause the death of the bacteria present, and then to carry on the absorption or

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encapsulation of the inflammatory exudate. This can be done in pus-collections containing a few cubic centimeters, but is not possible when the amount is much greater. It is best seen in small appendicular abscesses and in pyosalpinx, the pus obtained from the latter being sterile in a large proportion of cases examined.

Etiology.—In interpreting the results of bacteriological investigation on the varying flora of the exudate in acute peritonitis, it is necessary to recall the manner of infection of the peritoneal cavity, which differs in a considerable degree from that of other tissues of the body. The peritoneum may be invaded in four ways:

    I. From the general circulation, the so-called hematogenous peritonitis.

    II. By bacterial invasion from neighboring organs without perforation, or infection by continuity.

    III. Following perforation of any of the hollow viscera.

    IV. Infection from penetrating wounds or abdominal operations not perforating the viscera.

The first is a rare cause of acute peritonitis, and is usually the result of an infection by the pneumococcus or the tubercle bacillus. In either the disease is of little interest surgically, because the lesions are usually secondary to a severe infection in some other organ of the body, such as the lung, and are therefore wholly beyond surgical treatment. The second type, however, is a very important one, including as it does the group of puerperal infections and a certain number of cases of appendicitis. The puerperal invasion is a direct growth of the species causing the disease, along the extremely abundant lymphatics of the uterus and adnexæ, and thence to the peritoneal cavity through the lymph-spaces of the peritoneum. In the appendix the case is somewhat different. Here the organ may be surrounded by an abscess yielding on culture nothing but the colon-bacillus, while in sections of the organ properly stained the whole thickness of the wall will show an abundance of streptococci. The colon-bacilli of the abscess have been able to pass through the diseased tissues of the appendix and form an intraperitoneal abscess, and have outgrown the less vigorous streptococcus. Much the same form of invasion is seen in strangulated hernia, where the fluid contents of the hernial sac are found to contain bacteria in a certain number of cases, even though the intestinal wall is not gangrenous. In infections of this type it is probable *a priori* that the number of species found will be rather limited, and such is the case. In puerperal infection the streptococcus is the almost constant factor; in appendicitis and strangulated hernia, the streptococcus and colon-bacillus.

Perforative peritonitis, on the other hand, is a true polyinfection. Often as many as ten different species may be found, though it is very doubtful whether they all contribute equally to the peritoneal inflammation, the active agent being in this case also the streptococcus, with a secondary infection by the colon-bacillus. The reasons for the recent change of opinion concerning the active part taken by the latter in the pathogenesis of peritonitis are numerous. In the first place, the growth of the colon-bacillus is so rapid on all of the media in common use that other species, and especially the rather feeble streptococcus, are soon overgrown in plate-cultures and their recognition rendered impossible,

when by staining the tissues or in cover-glass smears from the perito-
neal exudate the streptococcus is found to be abundant. Another fact,
though not absolutely convincing, yet is of some importance, is the
relatively slight pathogenic property of the colon-bacillus when injected
into animals compared to that exerted by the streptococcus under simi-
lar conditions. Animal and human susceptibility to a given micro-
organism are not at all times parallel; but, as a rule, virulence to animals
can be accepted as some indication of its relation to man.

The mere discovery of the colon-bacillus in the peritoneal fluid a few hours before or
after the death of the patient cannot be assumed as an absolute evidence of its causative
connection with the disease, for it has been frequently shown—notably by Sanarelli in the
case of yellow fever, and by Hauser in other conditions—that the body is often invaded
immediately after death by the colon-bacillus, and in certain cases a considerable time before
the fatal issue. A report by Charrin and Veillon of the results obtained in a fatal case of
peritonitis appearing as a terminal infection in cirrhosis of the liver is of interest in this con-
nection. One hour after the death of the patient a small quantity of the peritoneal exudate
was withdrawn by means of a sterile syringe and was found to contain a pure culture of the
pneumococcus. Twenty-six hours after death an autopsy was made, and cultures obtained
from the abundant purulent exudate showed only the presence of vast numbers of the colon-
bacillus. Such a case would have ordinarily passed for a colon-infection, and is a fair exam-
ple of the difficulty encountered in the isolation of a feebly growing pathogenic germ in the
presence of a more vigorous saprophyte.

The peritonitis produced by infection during an operation or by
material carried into the abdomen by a stab-wound or pistolshot-wound
usually shows either the streptococcus or staphylococcus as the active
agent, the streptococcus being found most often. The infection in these
cases is often of a most virulent type, producing a rapidly spreading
peritonitis, soon becoming general. The modern high-speed bullet is
usually aseptic because of the heat produced by its high speed, and
hence the source of the infecting germs must be the clothing or skin of
the injured person. In stab-wounds, on the other hand, the knife is
usually dirty, and the injury produced is a more superficial one, and
therefore more liable to infection. To produce a bacterial peritonitis
several factors are necessary. The injection of a moderate quantity of
a cloudy culture of bacteria into the peritoneal cavity produces no
peritonitis; neither does the injection of the bacteria and their toxins;
both are rapidly absorbed by the healthy peritoneum. Sterile particles
of feces and sterile contents of the small intestine are equally innocuous.
There must be some injury to the cells of the lining endothelium in
order that the bacteria may find a place to grow and set up the tissue-
changes we call peritonitis. Such an injury may be produced by
drying of the peritoneal surface, by rough operative traumatism, by
irrigation with solution of mercuric chlorid, by chemical substances
exuded from an unruptured abscess in the abdomen, by unsterilized
particles of feces. Then and only then can there be produced a pro-
gressive peritoneal inflammation by the action of the bacteria. Particles
of feces are especially dangerous, because they not only act as foreign
bodies and irritate the delicate endothelium, but also contain in them-
selves the bacteria necessary to use this injured area as a place for
growth. They thus protect their contained germs from rapid absorp-
tion until they have a chance to grow. But the process is not in any
way dependent on the chemical compounds in the feces; it is entirely
mechanical; blotting-paper infected with a broth-culture of the germ

would do as well. When an abscess ruptures into the peritoneal cavity, it carries in the discharged pus the necessary elements for a spreading infection—the bacteria and their toxins in large quantity, hidden in solid particles of fibrin and necrotic tissue which act as a protection until an inflammation can be started in the as yet uninjured peritoneum. In those cases in which there has been sufficient trauma during the course of an operation, the simple presence of bacteria will start an active process in the weakened peritoneal coat, and there is no need of foreign particles to protect the germs from absorption. The classification of acute peritonitis should be based on the bacterial infection, because on the nature of the infecting organism depend the symptoms, course, and prognosis of the disease; but at present such a division is quite impossible, and pathological tissue-changes are the basis of our classification.

Pathology.—The pathological changes which take place in an acute inflammation of the peritoneal cavity are very variable, depending on the virulence of the infection, the length of time which has elapsed since the beginning of the disease, and the original site of the process.

The changes which occur at first are a slight congestion of the surface, often combined with small hemorrhages. This is always more marked over the visceral than the parietal layer, and also at the place where the inflammation originated. This stage corresponds to a swelling and proliferation of the endothelial cells and a beginning edema of the connective tissue beneath them. Cases dying within twelve to sixteen hours often show nothing more than this. If the process continues, there takes place an exudate of fibrin and serum in varying amounts. The serum is rarely in any great quantity, and soon becomes turbid and finally thick pus from the emigration of the leukocytes and the absorption of the excess of fluid by the peritoneum. The fibrin in the early stages forms only a thin layer over the serous surface; later it may increase in quantity and thickly coat the surface of the viscera. The pus may remain entirely free in the cavity, merely gravitating to the lowest points, such as the pelvis or the spaces to the outer side of the ascending and descending colon, or it may become encapsulated by the formation of adhesions between the loops of the intestines by the exudation of large quantities of fibrin. Anatomically these cases can be divided into (*a*) peritoneal sepsis, (*b*) acute general peritonitis, (*c*) progressive fibrinopurulent peritonitis, (*d*) localized peritonitis.

Clinically any sharper division than localized and general is rarely possible. If the patient does not die from the localized process, then a cure is sometimes possible by the abscess perforating either the abdominal wall or into the intestine, and thus draining itself; but this is rare. Dense adhesions then form about the site of the abscess and between the viscera, and the process becomes a chronic one, and finally ceases to be progressive.

The changes in the peritoneum in *tubercular peritonitis* are of a somewhat different type. The simplest form (*a*) is that in which there are miliary tubercles scattered over the surface of the peritoneum; this form is usually seen in connection with a general miliary tuberculosis of the rest of the body (*b*), a comparatively small amount of tubercle-tissue and a relatively large accumulation of serum (*c*), a form in which the loops of the intestine are matted together in a mass by the formation

of enormous quantities of fibrinous exudate (*d*), the final stage, in which besides the adhesions there are large sacculated accumulations of pus and cheesy débris. Cure after operation takes place by the encapsulation of the cheesy masses and the gradual change of the tubercle-tissue into simple fibrous tissue, in which no signs of a tubercular origin can be discovered. This process has been observed in a moderate number of cases in which a laparotomy or autopsy has taken place some time after some previous operation for the relief of the tubercular peritonitis. In these cases the peritoneum has been found to have regained its glistening surface, the adhesions have disappeared, and all that remains of the tubercles are fibrous thickenings of the peritoneal surface.

The paths of origin of the peritoneal infection by the tubercle bacillus are somewhat obscure. In cases of miliary tuberculosis the peritoneum is frequently found to be the seat of abundant small miliary tubercles, but this process is usually lost sight of because of the symptoms produced by the infection of the other organs of the body.

The infection may arise from the intestinal tract by the bacteria passing through the intestinal wall from a tubercular ulcer as a source, and starting an inflammation on the serous surface. This process is quite common in cases of phthisis, but rarely leads to any widespread peritonitis, being usually confined to the area of the intestinal wall occupied by the ulcer. By far the most important channel is probably the retroperitoneal lymphatics infected probably through tubercular food, milk, etc., or possibly through transference of the bacilli from the bronchial lymph-nodes, the pleura, and the lung to the peritoneum and retroperitoneal nodes. Finally a considerable proportion of the cases seen in women are undoubtedly primary in the genito-urinary tract, and spread thence to the peritoneum.

Symptoms.—The classic picture of general peritonitis offers but a slight interest to the surgeon. The drawn-up knees, the swollen abdomen, and the shrunken face are but indications that the time for operative interference is past. The whole aim of the surgeon should be, therefore, to make his diagnosis, and to attack the disease before the system has been poisoned beyond hope of remedy. To do this requires more than the mere observation and weighing of the ordinary symptoms. It requires the ability to judge of the patient's expression, to recognize the gravity of the situation irrespective of the exact temperature and number of pulse-beats. The early cases vary much in the severity of their symptoms, depending on the suddenness of the infection, its bacterial nature, and whether the process is local or general. When there has been a perforation of one of the hollow viscera and a large quantity of infectious material has been distributed about the peritoneal cavity, the rapid absorption of the toxins and bacteria causes a profound shock to the system, and may even cause the death of the patient within a few hours. Should this not occur, then the patient goes on either to a general peritonitis or to a localized abscess with encapsulation of the material which has escaped from the perforation. The symptoms in the first case will be extreme and sudden pain, at times general, at others localized at the point of the perforation or referred to the epigastrium. The prostration will be marked, the pulse feeble, the skin cold and clammy. Tenderness on deep pressure may

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be marked over the site of the rupture or may be entirely absent. There is only rarely a general tenderness over the abdomen; this is rather a later symptom dependent on the beginning of the active inflammation, and often does not occur until eight to twelve hours after the perforation. No possible decision can be made at this time on the probability of the localization of the infection, and delay only adds to the certainty that the patient's chances will become less the longer the period which elapses between the perforation and the operation for its closure. Cases in which there is a rupture of a localized abscess often show a remarkable improvement of the patient's subjective condition, due to the relief of pressure on the nerve-fibers of the abscess-wall; but the rapid quickening of the pulse and an ominous rising temperature point inevitably to the fact that an increase in the general septic condition is taking place. In other cases there may be absolutely no warning at the moment of the perforation and the beginning of the process of generalization, and this most often occurs in connection with gangrenous inflammation of the appendix. It is here quite natural to suppose that the nerve-fibers of the organ are involved in the necrotic condition of the rest of the tissues, and that the process of beginning leakage should bring but little shock to the surrounding peritoneum, already inflamed by chemical exudation from the appendix. In these early cases of peritonitis, unless there is a clear history of previous trouble, the diagnosis often has to be made on a very slight basis. The temperature may be low, not over 100° F. very often, with a pulse of 80 to 100, and only slight tenderness and disten-tion of the abdomen; yet the patient has an indescribable anxious, pinched look about the face that will enable a good observer to make a probable diagnosis. In advanced conditions the disease is compara-tively easy to diagnose. The most valuable symptoms are the pulse and the condition of the abdomen. The pulse in many of the well-advanced cases is peculiar, but easily recognized after a little experience. It is increased in frequency to 110 to 130, and is a little hard and snappy. The abdomen is tender, with the point of greatest sensibility at the place where the disease began, though in exceptional cases the most tender spot is on the side of the abdomen away from the point of origin. The abdominal muscles are rigid in the reflex attempt to pro-tect the painful viscera beneath, and there is a marked distention, due to the paralysis of the muscular coats of the intestine by the poison, and possibly several other factors, the infiltration of the wall of the gut by the inflammatory products and also the irritation of the inhibitory nerves. Chilly feelings are a common symptom; but actual chills are rare except in the puerperal form, when a severe chill frequently marks the beginning of the disease. In the latter type of infection diarrhea is frequently present, instead of the usual obstinate constipation. Vomiting is an important and early symptom, often beginning before pain or tenderness, and thus indicating its origin from the irritation of the peritoneal nerves. Later it assumes the characteristic form seen also in cases of intestinal obstruction from any cause—the quite constant regurgitation of the contents of the stomach into the mouth without any effort on the part of the patient. Finally the fluid becomes the true stercoraceous vomit, and is a symptom of the final stages of the

disease. Such cases can rarely be saved by any means, operative or otherwise.

The symptoms of the *tubercular form* of peritonitis are exceedingly variable. The disease may exist for a considerable time without giving symptoms of any sort, and only be discovered accidentally in the course of an operation for some other condition. This has been recently shown in connection with operation for the radical cure of hernia, in which the sac is not infrequently found to be the site of a tuberculous process, a part of the general involvement of the whole peritoneum. Other cases show no local symptoms, but only a gradual loss of health, with an evening rise of temperature and rapid heart-action. Or the disease may behave like an acute peritonitis or intestinal obstruction, with high temperatures, vomiting, rapid distention, and tenderness. The common forms usually show, besides the loss of flesh and strength, some local evidence of the tubercular process. The abdomen is swollen and hard; through its walls can be felt a variety of irregular masses composed of the new tissue. One of these masses which is suggestive of this disease is a long sausage-shaped tumor formed from the rolled-up and thickened omentum and lying across the upper portion of the abdomen. Occasionally fluctuation can be made out in one of the collections of pus or in the serous effusion.

Prognosis.—The prognosis of acute general peritonitis is dependent on (*a*) the pathogenic germ, (*b*) the amount and source of the infectious material, (*c*) the complicating disease, and (*d*) the time which elapses before interference. Peritonitis caused by the gonococcus, pneumococcus, or staphylococcus is less dangerous to life than that in which the streptococcus is present. The amount of infection is important for the reason that small amounts of pus and other septic material can be absorbed before they have time to set up an active inflammation, and a small quantity of fluid from the stomach is less likely to cause a violent peritonitis than an equal amount poured out from the colon. Between infections arising from the colon and those from the small intestine there is a considerable difference in prognosis. Although the bacterial content of the colon is far greater, both as regards the number of species and their number to a given bulk, yet the fluidity of the contents of the small intestine permits the escape of a greater quantity of infectious material, and by reason of this and of the greater peristaltic activity its distribution over the intestinal coils renders the small intestine area one of great seriousness in perforation. The disease which may accompany the escape of infection renders the application of operative relief far more dangerous than in a simple uncomplicated case. For example, the mortality in peritonitis complicating pneumonia is at least 80 per cent. of the cases operated upon, while that of ulcer of the stomach has recently fallen to 53 per cent. The chances of a case treated so early that no actual tissue-changes have taken place in the peritoneum must be infinitely greater than those in which the abdomen is filled with pus and fibrin and the patient's whole nervous system is poisoned by absorption.

The absolute mortality of general peritonitis is a matter very difficult to determine. Treated medically it is certainly over 90 per cent.; but here the doubt must always remain, in case of recovery, whether the

patient really had a general process or not. The same question arises in the discussion of surgical results; but here a greater amount of certainty is gained from the possibility of inspecting the surface of the intestines and determining roughly the presence or absence of inflammatory changes. Nevertheless, it is probable that a general peritonitis is a more fatal disease than the present statistics indicate, if for no other reason than that a successful case is far more likely to be published than a failure. The present statistics are based on over 200 cases of general peritonitis which have been operated on within the last few years. The results are that the mortality has been only about 60 per cent., which is a great advance over the best that can be done by purely medical means. Equally brilliant are the operative results obtained in the treatment of perforating ulcer of the stomach. The figures have been arranged by Mikulicz in a very striking manner. The number of cases operated on between 1885-1893 is 35, and of these only 1 was saved. In sharp contrast to this is the record between 1894-1896 of 68 cases, with 32 recoveries, a mortality of only 53 per cent. In operations since 1896 the mortality of those cases which received treatment before twelve hours had elapsed has been shown by Keen to have been less than 17 per cent., while cases from the same period, but allowed to go twelve to twenty-four hours, show a mortality of 43 per cent. A certain amount of improvement in operative technic during the last ten years no doubt contributes to this advance; but the most important point is the fact that, with the recognition of the disease as a surgical condition, the patients have been brought to operation early, the majority within twelve hours of the perforation. Operative interference has been carried out in 66 cases of perforation of an ulcer of the bowel in the course of typhoid fever. Of these, only 13 recovered, or a mortality of over 80 per cent. When one considers, however, that nearly all cases die if not operated on, and remembers the conditions under which the patient must submit to operation, these results must be acknowledged to be a very remarkable triumph of modern surgery. Of all forms of peritonitis, that in which the most benefit is obtained by surgical means is the tubercular form, although, curiously enough, the exact process by which the patient is benefited is not accurately known. All that is known is that after the abdomen of such a patient has been opened there takes place a reparative change resulting in the temporary improvement of at least 70 per cent. for a short time, and the permanent cure of at least 25 per cent. of those operated upon.

Treatment.—The treatment of peritonitis varies greatly because of the vast differences in the types and severity of the disease. A small localized collection of pus in the abdominal cavity is nothing compared to the same amount of infectious material when not walled off by barriers of plastic lymph. The location of the noxious substances in the peritoneum is also of the greatest importance; the pelvis, the fossæ external to the colon, and to a lesser extent the region anterior to the stomach and liver, are positions of the greatest relative safety. Exudates in these positions often become safely walled off in a few hours; while, on the other hand, an infection of the central portion of the abdominal cavity is well nigh inevitably fatal without prompt surgical interference, because of the rapid spreading of the bacteria by the peristaltic move-

ments of the small intestine. With the treatment of localized collections of pus in the abdominal cavity we shall not concern ourselves, for the subject is discussed under the titles of the organs from which such abscesses arise; but we shall simply describe the more approved methods of combating the two conditions, *spreading* and *general* peritonitis.

The indications, which are simple enough, are to remove the exudate and its contained bacteria from the peritoneal cavity with as little shock to the patient and as little damage to the delicate peritoneum as is possible, and, when this has been carried out, to prevent re-accumulation of the exudate.

Before entering upon the subject of operative treatment, which is called for in a large majority of the cases, it may be well to indicate the scope and limits of purely medical means. If the diagnosis has been made early and the condition is mild or localized, divided doses of calomel followed by a brisk saline purge may serve to remove some of the fermenting contents of the bowel and assist in the removal of the toxins from the peritoneal cavity. But it must be always borne in mind that the formation of adhesions or the possibility of perforation is an absolute contra-indication to the use of any laxative, so that the use of such treatment has come to be limited to post-operative cases. Local measures—poultices, stupes, ice-coils, and the like—serve chiefly to make the patient more comfortable, and probably influence very little the actual course of the disease.

Should operative measures be decided upon, shock is to be avoided by the use of an anesthetic, and ether is perhaps the best for its stimulant effect on the cardiac muscle, already weakened by the action of the absorbed toxins. To aid the general anesthesia and to diminish the amount of ether necessary to prevent any movement on the part of the patient, for that is all that is required, a moderate preliminary dose of morphin hypodermically is often valuable. Its effects are also desirable after the operation in quieting the patient and diminishing peristalsis, and it in no way interferes with the subsequent treatment by means of laxatives. In extreme cases it is advisable to use cocain or cocain combined with morphin for purposes of anesthesia, simply because any general anesthetic would inevitably be fatal; and though a very thorough cleansing operation is almost impossible under cocain, yet enough can be done by abundant irrigation and subsequent drainage to give the patient his best chance for life. One procedure which should never be omitted before any operation on cases in which there has been fecal vomiting or even a tendency to paralysis of the intestinal peristalsis and gaseous distention, is a thorough washing out of the stomach with a stomach tube. This apparently simple procedure obviates in a surprising manner many of the dangers of a general anesthetic. There can be no infection of the air-passages, with a subsequent septic pneumonia, because the patient does not regurgitate, as he would have done, the foul contents of his stomach and upper bowel, passed upward by a reversal of peristalsis and a weakening of the natural sphincteric action. There is less likelihood also of persistent vomiting after the operation, and the patient gains a period of relief and quiet.

The choice of an incision depends largely upon the condition one expects to find. If the infection follows upon the rupture of some one

of the hollow viscera, or the breaking of an abscess into the peritoneal cavity, and if the symptoms do not point to a general invasion of the whole peritoneum, then the opening should be made with a view to give the best possible exposure of the field to which the trouble may be confined. On the other hand, if the patient's condition shows that the infection has become a generalized one, the incision should be made in the median line long enough to give free access to all parts of the abdominal cavity. After this step there are two methods of procedure, careful mopping up of all exudate from the cavity and the loops of gut, or free irrigation with hot normal salt solution. The choice depends largely on the condition found. If the process is spreading, but does not involve as yet the whole of the peritoneum, it is manifestly improper to irrigate and thus spread the infection to tissues still intact. The rarity of a universal peritonitis is seldom appreciated. What usually passes for this condition is a fairly well-localized inflammation without any limiting adhesions.

A patient seen by the author well illustrates this point. The case came to autopsy after about three days' course of what would ordinarily be considered a typical general peritonitis, yet on opening the abdomen all the intestinal loops were free from signs of disease and still retained their luster; but in the gutter formed between the ascending colon and the lateral wall of the abdominal cavity was a large collection of foul-smelling pus, and the colon and the right half of the liver were covered with a thick coating of fibrin. The left half of the liver was absolutely free from any inflammation. So slight a barrier as the falciform ligament had prevented the spread of the infection, and demonstrated that peritonitis is a true infection by continuity, first local and capable of being arrested, and then general and beyond control except by most radical measures. Irrigation in this case would have simply spread the bacteria present over the whole of the comparatively healthy peritoneum and resulted in a rapid absorption of the toxins present and the early death of the patient.

In such conditions, therefore, it is wiser carefully to sponge out all the visible exudate with pads of sterile gauze which have been wrung out of hot normal salt solution. A certain amount of traumatic injury is necessarily inflicted on the delicate endothelial lining of the peritoneum; but this is far more easily cared for by nature than the additional toxemia which would have inevitably followed irrigation. This cleansing process should never extend beyond the visible limits of the disease; the remainder of the abdominal cavity is to be protected carefully by large, dry, sterilized gauze pads passed between the intestines and the abdominal wall, to be left until all the cleansing process is over. The removal of these pads from the abdomen is much facilitated by having a long tape firmly stitched to one corner: this also relieves the operator from the embarrassment and doubt of having left a pad in the abdomen. When the infection is undoubtedly general, the patient's life should not be risked by any prolonged search for the site of the perforation, but an ample median incision is to be made, and the whole peritoneal cavity thoroughly flushed with salt solution of a temperature of at least 105° F., or even higher, for it is well to remember that the temperature of the blood in these cases is often over 107° F., and to obtain any stimulant effect from the heat the solution should be several degrees higher. A temperature of the salt solution as hot as the hand can comfortably bear represents from 107° to 110° F., and is correct. When the water returns clear from all portions of the abdomen, it has accomplished all that is possible; but none of the dependent portions of the peritoneal cavity must be forgotten. Especial attention should be paid to the

pelvis and the spaces outside of the colon, and a long tube carefully passed down to each of these places to obtain the full cleansing of the stream. All easily loosened masses of fibrin and pus should be gently sponged off the surfaces of the viscera, and as much as possible of the fluid still in the abdomen should be absorbed by gauze pads. It is well to make two counter-openings, one in either flank, through which drainage can be made, and any accumulations in the depressions out-side the colon thus removed. The choice of the drain-material is between gauze and rubber tubes. Most operators at the present time incline to the use of gauze; some prefer to combine the two, using gauze wicks about the tube, but retaining the latter because of the ease by which the discharges can be removed by occasional irrigations with-out disturbing the dressings to any extent. In any case the material used must be capable of carrying off large quantities of fluid for the first forty-eight hours, as the absorptive power of the peritoneum is so reduced by the inflammation and the traumatism of the sponging and irrigation that it is utterly incapable of taking care of the fluid secreted.

Recently the suggestion has been made to remove the intestines from the abdominal cavity and forcibly scrub them with gauze pads wrung out of hot salt solution. During the process a continuous stream of the same fluid is to be kept flowing over the exposed loops, to prevent chilling and wash away the loosened masses of fibrin and pus. Such a method is certainly not applicable to cases with a great degree of septic absorption, in which the diminished strength of the patient often does not survive the anesthetic. Its field is more in those cases of fairly well localized peritonitis of a low grade of virulence and a tendency to produce large quantities of fibrin without much general poisoning of the organism, and in these it is unnecessary, and there-fore to be condemned. Another method which has as yet been but little used is a continuous bath. This plan of placing the patient in a bath of sterilized salt solution at 98° F., after opening the abdom-inal cavity, is indeed a rather heroic measure, but the results of its use in cases of suppurating joints and other severe infections would cer-tainly warrant its trial in desperate conditions. It certainly permits the freest exit for the discharge of pus lying between the coils of the intestines, and with the least traumatism. Experimentally it has been found that the peritoneum of animals would perfectly well endure an exposure of two hours in a warm normal salt bath without serious change in the lining endothelium. In man, however, no very remark-able results have been reported, probably because it has only been tried on moribund cases.

The suture of the incisions is rarely advisable; it takes time and prolongs the giving of the anesthetic. The sides of the wound can be easily held together by the dressings. In cases in which the distention of the intestines is so great that difficulty is experienced in returning them to the abdominal cavity, it is an excellent plan to puncture several of the most distended loops after their removal from the proximity of the incision, and thus permit the escape of their gaseous and fluid con-tents. A quick and perfect method of accomplishing this is by making a quick purse-string suture of three stitches at the point selected, between which a good-sized aspirator-needle pierces the bowel, relieving

gas and liquid contents without contamination of the neighboring parts. Before closing these punctures with a suture the most happy results have been obtained by the injection into the lumen of the gut of several ounces of saturated solution of Epsom salt. This promotes peristalsis, cannot be vomited, and thus carries off the poisonous contents of the bowels. An enema of 8 ounces of hot black coffee with an ounce of whiskey should follow operation.

The after-treatment must be sharply stimulating; strychnin hypodermically, in doses of $\frac{1}{40}$ or even $\frac{1}{20}$ grain, can often be given every two hours with great advantage; a little morphin may advantageously be given if required for pain or restlessness. The great advantage of the morphin is that it allows the patient to breathe with more freedom, because of the fact that such movement no longer causes pain, and thus permits the freer motion of the diaphragm, which is known physiologically to be one of the most potent factors in the causation of the flow of lymph, and hence of the absorption of fluids from the peritoneal cavity. An ice-coil to the abdominal wall is often exceedingly grateful to the patient, and no doubt relieves to a certain extent the congestion and inflammation of the diseased peritoneum.

The treatment of *tubercular peritonitis* rests upon an entirely different basis from that of the acute infectious condition. In this case we have a slow, rather chronic, pathological process which may be localized in peritoneum alone and which does not send into the circulation a large amount of toxic material. The operative technic is extremely simple. The mere opening of the abdomen is often sufficient to produce a cure. Any pockets of pus should be opened by a very gentle freeing of adhesions and the contents sponged out; but great care is necessary in all the manipulations of the diseased gut. In advanced cases the wall of the intestines is so invaded by the disease and so fragile that, if a tear should be made, it is almost impossible to suture it, the stitches almost invariably pulling out as they are tied. The danger is not so great in cases in which the tubercles are still discrete and there are no general adhesions; but even in these the omentum will often be found adherent in the line of the incision. Intractable fecal fistulæ have often resulted from attempts to break up adhesions between omentum and parietal peritoneum and intestine infiltrated by tubercle, by an accidental tear into the bowel. The use of free irrigation of various fluids, of iodoform powder scattered over the peritoneum, or of camphor-naphtol as recommended by Rendu, has not in any way increased the proportion of permanent cures. Apparently the peritoneal irritation by operation is sufficient to produce a cure. The advantages of laparotomy and irrigation under cocain, instead of a general anesthetic, are very great in these tubercular patients, as the operative manipulations are few and the patient escapes the danger of hastening any lung infection, such as is so often seen after the administration of ether in those who have a quiescent phthisis.

CHAPTER XI.

ACUTE INTESTINAL OBSTRUCTION.

THE conditions brought about by intestinal obstruction are those commonly known as ileus.

The principal causes of ileus are: Internal concealed hernia, intussusception, volvulus, bands, omphalomesenteric remains, etc., obturation of the intestines, and infarction of the mesenteric vessels.

Conditions may occur under which a considerable narrowing of the intestinal canal may exist for a long time without serious symptoms. Finally, changes take place which bring about suddenly a complete obstruction to the onward flow of the contents of the canal. Such an obstruction exerts an influence not only upon the whole length of the intestinal tube and its contents, but also upon the point at which the constriction occurs. Locally there is a powerful disturbance of the circulation, and consequently of the vitality of the parts constricted; and this condition existing in a sensitive organ produces more or less shock to the system.

At the same time an accumulation of the intestinal contents begins to take place above the point of constriction. There is more or less venous congestion in the immediate neighborhood of the obstruction, accompanied by a venous exudation and paralysis of the intestinal wall.

Under ordinary conditions the products of decomposition are comparatively small in amount, but now changes occur in the albuminoid substances which favor their development. There is consequently an abundant accumulation of gas which the paralyzed bowel, with its enfeebled circulation, is unable to absorb. The putrefaction which takes place normally in the large intestine is now found in the small intestine. When the distention of the bowel becomes sufficiently marked, there is an effort at peristaltic action which results in a contraction of the intestinal wall. Owing to the impossibility of the contents passing downward, they are forced upward; and as this process continues the intestinal contents are finally emptied into the stomach, and vomiting takes place, which finally becomes stercoraceous.

If the obstruction has continued for any considerable length of time, a hypertrophy of the intestinal wall may also be found. In the chronic form of obstruction this thickening may produce quite an appreciable change in the appearance of the wall of the intestine. (In experiments on dogs this change has been observed as early as the ninth day.) When the walls are stretched by the accumulation of the intestinal canal, the pressure exerted by the firmer portions, such as scybala, may cause ulceration, and perforation may take place.

Below the point of obstruction little or no contents are found in the

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intestinal canal, and its walls are often contracted. A certain amount of feces may, however, be found in the distal portion of the canal at the time of obstruction, and their removal by enemata may give an erroneous idea as to the permeability of the intestinal tube.

The constriction caused by a band may produce strangulation of a loop of intestine or gangrene of some of the structures involved. This will pave the way to a peritonitis which may become general. The presence of adhesions, however, may wall off the sloughing surfaces, and when extravasation of the contents of the bowel follows as a result of perforation, a fecal abscess or fistula may be developed as one of the sequelæ of the obstruction. When the meteorismus becomes extensive, pressure is exerted upon the diaphragm and respiration becomes more shallow and frequent.

General Symptoms.—The general appearance of a patient in this condition is quite characteristic. The "facies" is usually well marked. The face is pale and the eyes are sunken. There is more or less cyanosis, due to the impeded respiration or, earlier, to the shock attending the obstruction. The nose is pinched and the skin clammy. The extremities are cold and the body-temperature is often subnormal. Even the tone of the voice is altered. The pulse is small, weak, and rapid. The cardinal symptoms of obstruction are pain, vomiting, tympany, and tumor. These may vary greatly according to the nature and acuteness of the obstruction. Pain is not always present, and is not always referred to the seat of the constriction. It is due largely to the increased peristaltic action caused by the efforts of the intestines to break through the obstructed point. Visible outlines of coils of intestine are seen, often arranged in horizontal rows one above another. Increased peristaltic action is indeed a characteristic symptom of obstruction.

Vomiting is an almost constant symptom. The vomitus consists first of the contents of the stomach; later either of a watery or greenish fluid, and finally the characteristic odor of fecal vomiting is observed. This peculiar odor is due to the chemical changes taking place in the proximal portion of the canal. Actual vomiting of fecal matter is exceedingly rare, and occurs only when the obstruction is low down in the large intestine.

Tympany varies largely according to the seat of the obstruction: it is more extensive the lower the constriction. When obstruction occurs high up in the small intestine, it may be absent. A fulness of the umbilical region often points to a distention of the small intestine by gas, a depression in the lines indicating the collapse of the colon. The presence of a tumor is quite characteristic of certain forms of obstruction, such as intussusception. Local meteorismus may give a tumor-like formation, as in volvulus.

After the lower bowel has been emptied of its contents there is persistent constipation. In certain forms of obstruction there may be stools consisting of blood or mucus, but no fecal matter is found in them.

General Treatment.—Much may be done to relieve the patient from the distress attending obstruction of the bowel pending a decision of the question of laparotomy. The lower bowel may be emptied by

a high rectal enema, which at the same time gives valuable information as to the permeability of the colon. The strength of the patient must be sustained by nutrient enemata, as no food can be retained by the stomach. The introduction of normal salt solution into the rectum will often allay an annoying thirst.

Cathartics, needless to say, are contra-indicated, but are nevertheless often given as the result of a faulty diagnosis. They increase the pain and vomiting, and tend to lower the vitality of the patient. Liquid may be given by the mouth, although it is not long retained. A portion of it may be absorbed, and the remainder serves to wash out the stomach. Lavage is strongly recommended by many surgeons. In this way the proximal bowel can be cleaned out, and the fecal vomiting may be arrested for considerable periods of time. The continued use of lavage and enemata may keep the whole intestinal canal clean and prevent septic absorption from the mucous surface. The strength of the patient may in this way be sustained, so that he is better able to meet the ordeal of a laparotomy.

Opium may be used to relieve pain and give repose. It does not have a deleterious action in any of the morbid conditions associated with obstruction, but it may mask a grave condition and give rise to fatal delay.

Internal Hernia.—Internal herniæ are those which lie entirely within the abdominal and thoracic cavities, or those which form beneath or behind the peritoneum without making their way outward. They are all exceedingly rare forms of intestinal obstructions.

1. To the first group belong those known as retroperitoneal herniæ. These are: (*a*) Hernia into the fossa duodenojejunalis; (*b*) Pericecal hernia; (*c*) Intersigmoid hernia.

2. Those known as properitoneal hernia, or those forms of interstitial hernia which lie wholly within the abdominal cavity ("internal interstitial hernia").

3. Hernia into the foramen of Winslow.

4. Diaphragmatic hernia.

Hernia Duodenojejunalis.—This form of hernia was called mesenteric hernia by Cooper and retroperitoneal hernia by Treitz, by whom it was first correctly described in 1857. Its striking peculiarity consists in the almost total disappearance of the small intestines behind the peritoneum, so that when that cavity is opened they are not to be seen (Fig. 174).

The point of origin of this hernia is the fossa duodenojejunalis, which is formed beneath a fold of peritoneum at the point of junction of the jejunum and the duodenum. This fossa can be exposed on the cadaver by throwing up the omentum and transverse colon and pressing the mass of small intestine to the right. In well-marked cases it is found lying to the left of the third lumbar vertebra, with its opening looking upward and inward. The margin of this opening is formed by a fold of peritoneum near the point where the duodenum emerges from its retroperitoneal position to receive a mesenteric attachment. In the lower border of this fold lies the inferior mesenteric vein and also the colica sinistra, a branch of the inferior mesenteric artery. The fossa contains more or less of the angle of the bowel, and sometimes the whole of the loop.

As the hernia develops, more and more of the jejunum and ileum pass into the fossa and raise up the posterior wall of the peritoneum passing behind it. As the sac enlarges, the walls of the transverse and

descending mesocolon become engaged in it. In case the posterior wall of the peritoneum is unusually adherent to its natural base, the intestines may push between the layers of mesocolon, which will then form the walls of the sac.

When fully formed, only the stomach, duodenum, and large intestine are seen when the abdomen is opened, a large tumor formed by
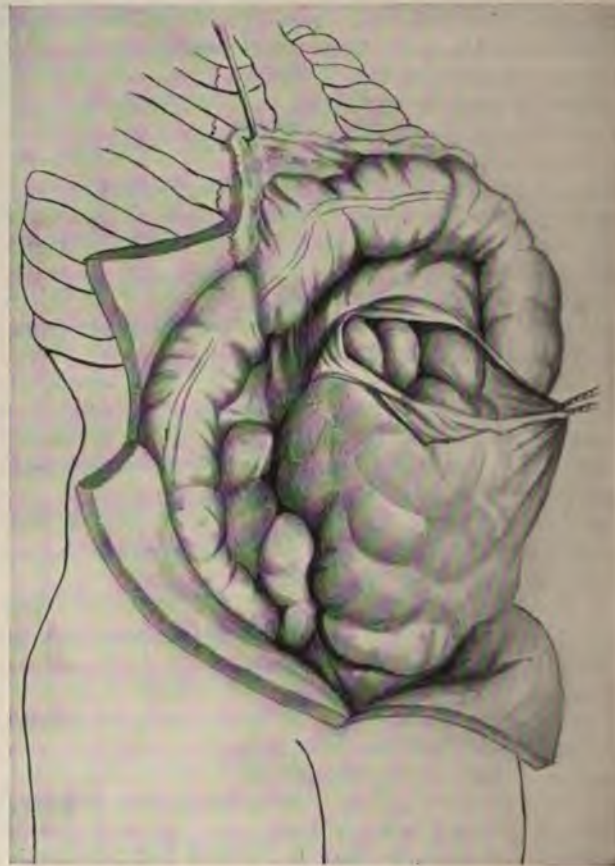
FIG. 174.—Hernia into the fossa duodenojejunalis (after Cooper).

concealed coils of small intestine filling the square enclosed by the colon. As the mouth of the fossa looks to the right, the fundus of the fossa enlarges to the left, and the tumor is therefore observed chiefly in the left half of the abdominal cavity. It may extend downward as far as the promontory of the sacrum. It is in rare instances observed in the right side of the abdomen. The youngest case mentioned by Leichtenstern was that of a child two months old; the oldest, sixty-five years. It is, however, more frequent in adults, and is observed chiefly in males. Manski has tabulated 66 cases, most of which were accidentally found at post-mortem examinations of individuals who had

died of other diseases. It is rare that strangulation of the bowel occurs.

The *symptoms* of retroperitoneal hernia are those of constipation, colic, and dyspepsia, with tumor in the left half of the abdominal cavity, giving the impression of a somewhat movable cyst, which, however, is not dull on percussion. Intestinal sounds can, moreover, be heard on auscultation. The pressure upon the inferior mesenteric vein may give rise to hemorrhoids. A few cases of acute strangulation have been recorded, with death in from two to eighteen days.

Treatment.—In case a diagnosis has been made, the abdomen should be opened and the neck of the sac and its anterior wall should be freely incised, care being taken to secure the large vessels which encircle the neck of the sac at this point. Internal adhesions are not reported, although Manski describes a case in which the neck of the sac had become obliterated by adhesions.

In a case of apparent acute intestinal obstruction in a man, forty years old, operated upon by Clark, this form of hernia was found, and was reduced by withdrawing the whole of the small intestine from an aperture at the lower part of the hernia. The patient gradually sank after the operation.

Pericecal Hernia.—According to Gray, there are three varieties of the pericecal fossæ: the superior ileocecal, the inferior ileocecal, and the subcecal. The latter often contains the appendix. Manski reports 12 examples of this variety of hernia: 8 were male adults; 1 a child fifteen months old. In nearly all the cases there were symptoms of intestinal obstruction. The amount of bowel involved in the hernia varied from that of a single loop to the greater portion of the small intestine.

Intersigmoid Hernia.—The fossa intersigmoidea lies in the mesentery of the sigmoid flexure. It is rarely seen in adults. It appears to be produced by the presence of the sigmoid artery. The opening into the fossa is sometimes in the form of a fissure and sometimes in the form of a valve. This form of hernia is exceedingly rare, Manski having succeeded in collecting but 3 cases. One of them is described by Jomini. A patient had died of cancer of the stomach, in which the sac contained the lower portion of the duodenum and the whole of the small intestine. It was supposed at first to be a hernia of the fossa duodenojejunalis.

Properitoneal Hernia.—The various forms of this hernia which lie within the abdominal cavity are due to certain mechanical conditions existing in umbilical, inguinal, or femoral hernia, whereby diverticula are formed spreading along the inner surface of the abdominal wall in front of the peritoneum (see Chapter XV.).

Hernia into the Foramen of Winslow (*Hernia Bursæ Omentalis*). —The small intestine has been frequently found to have passed through this opening into the lesser cavity of the peritoneum; the colon has also been found in the hernial sac. It is met with in adults, and in men more frequently than in women. Treitz did not consider this form a true hernia, as there is no hernial sac.

The *symptoms* appear to be those of intestinal obstruction, with a tumor in the epigastric region. The attack begins with sudden abdom-

inal pain. In the case operated upon by Neve, intussusception was suspected. There is a change in the size and shape of the tumor according to the amount of gas the imprisoned intestines contain from time to time.

In a case operated upon by Treves attempts at reduction failed, and at the autopsy it was not until the hepatic artery, the portal vein, and the bile-duct had been divided that the hernia could be reduced.

Treatment.—Neve performed a laparotomy in a male, seventeen years of age. A 3-inch incision was made along the right linea semilunaris. Above the umbilicus, but below the tumor, a portion of the colon and small intestine had passed through the foramen of Winslow. They could not be reduced by traction. Not wishing to divide the artery, vein, and duct, the operator closed the abdomen. An enema given two nights later, after prolonged abdominal pain, gave great relief. Spontaneous stool two hours later. Dressing on the seventh day, when it was seen that the tumor had disappeared. Patient discharged well in twenty-six days.

Diaphragmatic Hernia (Fig. 175).—This term is used to denote the passage of the abdominal viscera through an opening in the diaphragm into the thoracic cavity. The hernial contents may be covered by the peritoneum, or may lie free in the thorax. In accordance with this anatomical difference the herniæ are classified as true or false. The latter are more frequent than the former. The opening through which the hernia passes is found more frequently in the muscular than in the tendinous portion of the diaphragm, and in the posterior than in the anterior portion of the diaphragm. Owing to the position of the liver, by far the greater portion of these herniæ are on the left side. The openings in the diaphragm through which they more frequently pass are: the esophageal foramen, a gap between the sternal and costal portions of the diaphragm, and similar gaps between the lumbar and costal portions of the muscle. Hernia may also occur through a wound in any portion of the diaphragm. The size and contents of these herniæ vary from a small bit of omentum to half the contents of the abdomen. Of the abdominal organs, the stomach is most frequently displaced; then the transverse colon, omentum, small intestine, spleen, liver, pancreas, and kidneys in the order named. The only organs which are never present are the bladder, the rectum, and the genitals.

The **causes** of this form of hernia are either a congenital deficiency (Fig. 100, page 190), a weakening of the diaphragm at some point, a dilatation of the natural openings, or trauma. The forms of traumatism are penetrating stab- or shot-wounds of the left of the abdomen and thorax, falls from a height, and great jarring or crushing. This hernia is not exceedingly rare, about 300 examples having already been collected. It has been found in patients of all ages, although persons with this affection do not often reach an adult age. It is more common in males than in females. Certain occupations predispose to it; thus it is often met with among sailors, soldiers, slaters, and carpenters.

This affection frequently remains latent for years, and is not recognized during life. It is most frequently discovered at the autopsies of children who have died of some other disease, but sometimes also is found in the bodies of aged persons.

Symptoms.—In other cases more or less distressing symptoms are caused which may be referred to disturbances of the thoracic or digestive organs. The disease for which it is most likely to be mistaken is pneumo-

thorax. In a typical case, in which are a contraction of the abdomen and distention of the left half of the chest, which is tympanitic, with little or no respiratory movement, the heart is displaced to the right. Among the subjective symptoms are pains of different kinds in the
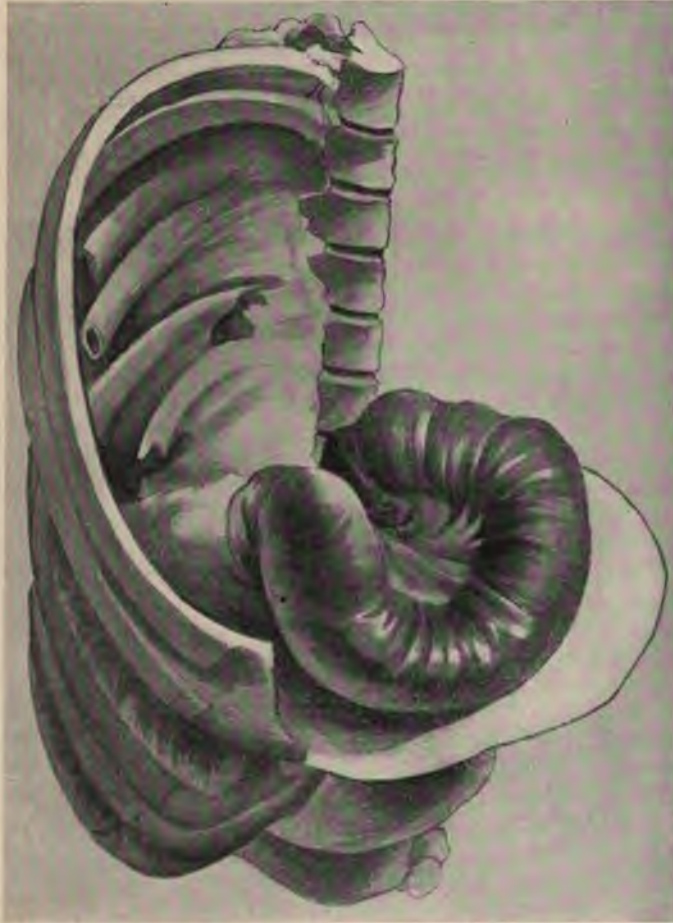
FIG. 175.—Diaphragmatic hernia (after Cooper).

abdomen and thorax, and sudden attacks of dyspnea, often without exertion.

Death is often caused in this disease by acute pulmonary affections. Much less frequently acute strangulation is the cause of death. This may occur by constriction of the stomach or bowel, or by a twisting of the displaced colon about its mesentery. The symptoms of strangulation come on often after excesses at the table, or violent efforts at lifting, or unusual straining. The condition is one the possibility of which should not be forgotten in considering the question of intestinal obstruction.

Treatment.—Diaphragmatic hernia has been operated upon with success by Humbert, Leisrink, Postempski, and Mikulicz. Abel reports a case in which the diagnosis was made, but the operation was unsuccessful in preserving life.

O'Dwyer reports a case of congenital diaphragmatic hernia in a child three and one-half years old, supposed to have empyema of the left side. An opening was made in the sixth intercostal space, when a loop of intestine escaped. It was returned and the wound closed. The next day an incision was made in the tenth intercostal space, and a hole in the diaphragm 1½ inches in diameter was discovered. Three inches of the ninth and tenth ribs were resected, and the bowel reduced and the wound sutured. There did not appear to be sufficient room in the abdominal cavity for the intestine, which forced up the diaphragm and filled one-half of the pleural cavity. The child died six hours later.

Dalton reports a successful case of operation for stab-wound of the diaphragm by resection of portions of the ribs and suture of the diaphragm with catgut. Borsuk reports a similar case in which there was hemorrhage, and which proved fatal. He suggests that laparotomy would probably have been a preferable method, and advises it in left-sided hernia.

Intussusception.—This term is used to denote a condition in which one portion of the intestine is introduced into the lumen of an immediately adjoining portion. The walls of the intussusception are composed of three layers: The outer layer is called the *intussuscipiens*, or sheath; the two inner layers, which belong to the invaginated portion, are called the *intussusceptum*. The innermost cylinder is known as the entering layer, and the middle as the returning layer. Between the two latter lies that portion of the mesentery which has been drawn into the tumor. This portion of the mesentery which is folded up into a cone-shaped mass, pulls upon the lower border of the intussusceptum, and throws it into a curve the concavity of which is directed toward the mesenteric portion of the intestine. The inner orifice of the intussusceptum, which originally was circular, is drawn into an elongated slit by the traction thus exerted.

The above-described condition is known as *complete intussusception*, in contradistinction to the incomplete variety, which is characterized by a drawing in of one portion of the intestinal wall only. This is produced usually by a tumor which drags upon the wall in virtue of its weight, being assisted by the pressure exerted by the column of feces. The incomplete may eventually become a complete intussusception. When the tumor is not large enough to act by its weight, it is probable that a spasmodic action of the bowel is the cause of the invagination. It may happen that the intussusception being arrested in its development, the whole intussusception may become invaginated into the bowel below, and a doubled or five-layered invagination is thus produced. This form occurs in the transverse colon and sigmoid flexure. Even a third fold of bowel is in rare instances invaginated. Occasionally there may be several intussusceptions in the same individual. In nearly all cases the intestine is invaginated into the segment below. Rarely, however, the invagination takes place in the opposite direction.

Theories as to the mode of development of the invagination differ considerably. Some authors believe that a segment of the bowel having become paralyzed, this portion is turned in and is invaginated into the normal intestine lying below the paralyzed portion. This is known as the "paralytic form." The "spasmodic form" is supposed to be produced by a tetanic contraction of certain fibers of the intestine, thus forming a cone which is driven by peristaltic action from above into the bowel below, or that the contracted portion forms the sheath, the bowel above being forced into it. The sphincter-like action of the bowel at the ileocecal opening can, under conditions of irritation, produce a tenesmus which favors a prolapse of the bowel, such as is seen frequently in the case of the rectum. There is a physiological as well as a pathological variety of the intussusception. The agonal invaginations

which occur at the time of death are short, often multiple, and have no surgical importance. They are produced by the varying moments of death of different portions of the intestine.

Varieties.—Invagination may take place in any part of the intestinal canal ; but there are four principal varieties : the enteric, the colic, the ileocecal, and the ileocolic. According to Leichtenstern, the ileocecal are by far the most common (44 per cent.) ; the enteric comes next in order of frequency (30 per cent.) ; those in the colon next (18 per cent.) ; and ileocolic last (8 per cent.). Wiggin found the frequency of the ileocecal variety as high as 89 per cent. in 103 cases. The seat of the invagination varies according to the period of life. Ileocecal invaginations occur most frequently in children. Seventy per cent. of cases in children are of this variety. Colic intussusception is also more frequent in childhood. On the other hand, invaginations of the small intestine are seen more frequently in adults. They are found chiefly in the lower portion of the ileum.

The tumor develops at the expense of the sheath, more and more of which is constantly turned in, so that the internal orifice or apex of the intussusception is always at the same point of the bowel. This is true of all varieties except the ileocolic (Fig. 176), which is produced by an

FIG. 176. — Ileocolic intussusception (Warren Museum).

FIG. 177.—Ileocecal intussusception, appendix showing below apex (Warren Museum).

invagination of the ileum through the ileocecal valve, so that as the intussusception forms, more and more of the small intestine is pushed into the colon, and the apex changes constantly. In this respect it differs from the ileocecal variety, in which the valve is always at the apex of the intussusceptum (Fig. 177). If adhesions of the inverted ileum take place, it will cease to enter the tumor, and the cecum will be turned in, the intussusception now forming at the expense of the colon. The amount of bowel involved in an intussusception may at times be quite large. In those which originate in the neighborhood of the cecum, the invaginated bowel may reach or even protrude through the anus.

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Etiology.—The causes which bring about a paresis of a limited portion of the intestine associated with vigorous peristaltic action are those which favor intussusception. Among these may be mentioned obstinate constipation, acute indigestion from gluttony, and the presence of an intestinal polyp or malignant growths. Trauma also plays a more or less prominent rôle: "dancing" the baby or jumping rope. In a case seen by the writer, a boy of ten brought on an attack by dragging himself to and fro on his belly over the edge of a table.

Age and sex exert a most important influence. The disease is seen most frequently during the first year, and chiefly between the fourth and sixth months. It is much more frequent in males than in females, 75.4 per cent. being males (Wiggin). The frequency of the affection in infancy is supposed to be due to the greater mobility of the colon, owing to its loose attachment to the iliac fossa, and also to the greater sensitiveness of the intestines.

After the invagination is established, the pressure upon the portion of the mesentery involved produces a passive hyperemia by obstruction of the flow of venous blood. This gives rise to edema and extravasation of blood in the mucous membrane of the intussusceptum, and sometimes to hemorrhage from the mucous surfaces involved. Such structures readily become septic, and a local peritonitis is the result, which either becomes general and causes death, or is limited to the intussusception and gives rise to adhesions between the middle and inner tubes. The inflammation in the more chronic cases produces a great thickening of the walls of the intussusception and transforms the mesentery into an indurated cord. If the constriction of the bowel is sufficiently tight, death of the invaginated portions may occur, and in this way the whole of the intussusceptum may be cast off and be discharged through the lower bowel, and a spontaneous cure be thus effected. This may be accomplished piecemeal, or a tube of intestine from a few inches to 3 yards in length may be discharged per rectum. Ulcerations and perforations of the outer tube, or of the intestine above the invagination, are rare, but occasionally occur. After a successful separation of the bowel a stricture may develop at the point where adhesion of the upper and the lower bowel has occurred, or intestinal obstruction by adhesion may occur. Such a case was observed by the writer in a pregnant woman, who after confinement died from the obstruction caused by the adhesion.

Symptoms and Course.—Intussusception may be either acute or chronic. The former may be peracute, acute, or subacute. In the peracute cases, which occur chiefly in children under one year of age, death may occur within twenty-four hours, with the symptoms of shock. They are, however, very rare. The acute form may last from one to two weeks; and in the subacute the disease may be of six weeks' duration. The chronic cases may be prolonged indefinitely, and may last even several years. The earliest symptom is usually pain, which is sudden and severe, and appears as a violent colic coming on in the midst of apparent health. Its situation is uncertain, and it does not necessarily correspond with the actual seat of the lesion. It is usually referred to the region of the umbilicus. After a few hours, especially in children, the pain ceases, and some time may pass before a second

paroxysm occurs. The pain is more intense in character than in any other form of obstruction. This symptom is soon followed by vomiting, which may eventually become stercoraceous. There is nothing especially characteristic about the vomiting except in the rarity of its becoming fecal. A very characteristic symptom is the evacuation of bloody stools with diarrhea. When the obstruction is high up in the canal the first discharges are fecal. The venous congestion of the constricted bowel causes the discharges soon to become mixed with blood. Bloody stools occur in three-fifths of the cases and appear on the first day. This symptom is a very important one, because, with the exception of twists and knots, no other form of obstruction is accompanied by bloody evacuations. Such discharges may, however, occur in dysentery and in rectal polypi in children. If the peristaltic action of the intestines is arrested, the discharges may consist solely of mucus and blood. They are accompanied by tenesmus, and the sphincter is often relaxed and retracted.

One of the most important symptoms is tumor. It occurs in about two-thirds of the cases. It may be found in the right iliac fossa or near the splenic flexure; it may also be felt by digital examination in the rectum. It is cylindrical or sausage-shaped, and, owing to the fact that tympanites is not seen in the early stages, it can often distinctly be felt by palpation of the abdomen. It is movable and not tender, and often changes its situation. It is felt principally in colon and ileocecal invaginations, but is seldom observed when the intussusception occurs in the small intestine. A protruding anal tumor is observed in about 6 per cent. of the cases. It can usually be detected, when present, by palpation of the abdomen or by digital examination of the rectum. By a conjoined abdominal and rectal examination, a tumor has been revealed which could not be discovered by either method used separately.

The temperature at first may be subnormal, and is not high and persistent unless peritonitis and sepsis occur. The pulse is rapid, and with the symptoms of shock there is a marked loss of strength. The eyes become sunken, the face pallid, and the voice weak. Death may occur, accompanied by convulsions or symptoms of heart-failure. Occasionally the fatal end comes suddenly. In case death does not occur at an early stage the bowels may become spontaneously reduced. The opinion has been expressed that invaginations often occur and are reduced, and that many of the severe colics in children may depend upon this cause. If, however, it remains invaginated, adhesions may occur. The time of their development has been placed by authors as early as the third or even the second day. In a case operated upon by the writer, there was no sign of adhesions forty hours after the beginning of the attack. Although the occurrence of adhesions is a distinct obstacle to reduction, it is a great safeguard against peritonitis due to gangrene of the intussusceptum. This complication occurs more frequently in adults than in children. It does not generally occur until after adhesions have had time to develop. In one case, however, the gut is reported as becoming gangrenous twenty-eight hours after the first onset. If the line of demarcation forms in the middle segment first, the cast-off segment of bowel will have its serous surface outside. If, on the other hand, the inner segment separates first, the

mucous surface will be external. The gangrenous bowel when discharged may have attached to it a polyp or Meckel's diverticulum (Eichhorst). It may be discharged in fragments. The casts of the mucous membrane seen occasionally in dysenteric attacks should not be mistaken for such fragments. The slough is discharged between the eleventh and twenty-first days in the majority of cases. Separation takes place most frequently in ileum invagination. Cure by sloughing of the protruding anal tumors was observed but twice in 103 cases. During the progress of separation of the sphacelated portion perforation may take place and produce a fatal peritonitis; or a suppurative phlebitis may occur with thrombosis, embolism, and metastatic abscesses. Even if these dangers are avoided, a subsequent constriction of the bowel may develop at the site of the lesion and obstruction occur.

The symptoms of obstruction may temporarily be relieved and the swelling in the intussusception subside, and a passage once more open through the bowel. The disease will then assume a chronic course.

Diagnosis.—The prominent features of a case of acute intussusception in a healthy infant or child are the occurrence of a sudden attack of acute pain with more or less collapse, its recurring character, the presence of bloody mucus having the appearance of currant-jelly in the stools, and of a sausage-shaped tumor. By the time the physician has arrived the first onset of the attack has subsided, and the child has not the appearance of one gravely ill; the abdomen is soft and not painful to the touch. If the symptoms above mentioned are present, there need be little doubt about the diagnosis. According to Rotch, there is no other disease in which an infant will be attacked so suddenly with the clinical symptoms of abdominal pain combined with bloody discharges from the bowels.

Prognosis.—The prognosis is always grave. The younger the patient the more unfavorable it is. Leichtenstern gives a mortality of 88 per cent. during the first year of life. This decreases slightly up to the tenth year. From the eleventh to the fifteenth year he gives the mortality as 63 per cent. Later on in life there is a slight increase in the mortality. The prognosis is somewhat more favorable in males than in females. As intussusception of the ileum is more likely to be followed by separation and discharge of the invaginated bowel, so the disease in this region is found to yield more favorable results than those in the colon or at the cecum.

Treatment.—The first onset of pain must be treated by local fomentations and opium, which also will quiet peristaltic action and prevent a growth of the invagination. No attempt need be made to give food, as it is certain not to be retained. Thirst may be relieved by small quantities of hot water. The principal features of the treatment must be mechanical. Among the most prominent methods employed is that of the introduction of water or air into the rectum. Hydrostatic pressure is preferable to the use of air, as the force exerted can be more carefully regulated. Rotch has found by experiment that a column of 6 feet is held by the intestine, but that it is wiser not to use more than 4 or 5 feet. He points out that it is always the case that the invaginated portion of the intestine is not on a line with the axis of the canal, but at an angle. Hydrostatic pressure therefore tends in such cases to push

the different layers closer together and prevents reduction. Also beyond a certain time it is not only dangerous from possible rupture, but also of no use whatever on account of the adhesions which have taken place. Rotch regards hydrostatic pressure as a legitimate procedure only in the very early hours of the case. The fluid used should be warm salt solution (one teaspoonful to a quart of water). The amount given should be about one quart, and the child should be held in the inverted position while it is administered. When reduction of the bowel is effected a characteristic gurgling sound is sometimes heard.

The testimony of Wiggin, who has had a case successfully treated by enemata, is strongly against this method. Of 103 cases collected by him, intestinal distention was practised in 72 of this number; and failure to effect reduction occurred in 54 instances, or 75 per cent., which figure would have represented the mortality of this method of treatment had not other methods been employed afterward. According to Mortimer, the chief advantage of hydrostatic pressure lies in the slight parental opposition to its employment.

Laparotomy for this form of obstruction may be regarded, when compared with enemata, as a method of precision. An incision should be made in the median line below the umbilicus, and this can be extended upward if necessary. It should be from 4 to 5 inches in length. The tumor, being grasped by the operator, should be gently drawn forward, and any other protruding loops of intestine should be carefully walled off. The entering bowel being held between the thumb and forefinger of the left hand, the right hand grasps the tumor and exerts gentle traction on the sheath, while it at the same time brings pressure to bear upon the apex of the intussusception. By this maneuver the sheath presently begins to unroll and the invagination is reduced. If after a few moments of trial this method does not succeed, the neck of the sheath should be cleared, and gently dilated by the finger or some blunt instrument, after which the bowel will begin to unroll. Traction on the intussusceptum should not be employed. The bowel and mesentery should next be carefully inspected, and, if in good condition, returned to its position in the abdominal cavity. Some operators suggest the advisability of suturing the bowel and its mesentery to the abdominal wall in order to prevent recurrence of the invagination. In the 2 cases operated upon successfully by the writer, this precaution was not attempted.

Wiggin's tables give a mortality of 67.2 per cent. for laparotomy. Excluding cases in which either the operation was abandoned, the bowel incised and an artificial anus made, resection attempted, or an anastomosis effected, there are 45 cases, in which 24 resulted fatally, or a mortality of 53.4 per cent. Counting only the operations that have been performed since the perfected technic of abdominal surgery has become generally known—since 1889—and throwing out those cases in which the operation was not completed, we have a total of 18 cases, of which 14 were successful and 4 unsuccessful, giving a mortality of only 32.2 per cent. This Wiggin believes to be a fair estimate of the risk to-day of laparotomy performed in a young infant for the relief of this disorder, if performed within the first forty-eight hours of the onset. This gives a chance of success represented by 78 per cent., which, according to this author, would speedily rise to 90 per cent. as the cases come more frequently to operation during the first twenty-four hours.

In weighing the relative merits of laparotomy and hydrostatic pressure in the early treatment of intussusception, it may be concluded that, inasmuch as in its early stages of development the invagination is some-

times spontaneously unrolled, and perhaps more frequently than is generally supposed, it is capable of being pushed back by the gentle use of enemata, and that hydrostatic pressure is therefore permissible in cases that are seen within twelve hours from the beginning of the attack. It should, however, be employed with great gentleness, with the object solely of acting on those cases which are easily reducible. It should only be employed on patients who are in good general condition. In case a well-marked tumor is present, the symptoms are pronounced, and twelve hours have elapsed from the time of their first onset, it is wiser to resort at once to laparotomy without handicapping the operation by previous treatment. Beyond the time above prescribed enemata are entirely out of the question in acute cases. Hydrostatic pressure might, however, be given a full trial in chronic cases. If the tumor prove irreducible by taxis, there are several operations which may be adopted, such as: (1) opening the sheath and excision of the intussusception; (2) excision of the intussusception, with end-to-end suture; (3) enterostomy; (4) intestinal anastomosis.

Excision of the intussusception may be employed when the tumor is irreducible or when the contents are gangrenous. It would not be applicable to cases in which the vitality of the sheath was in question. It may be performed in the following manner: A longitudinal incision is made on the outer aspect of the sheath lying near the point of junction of the upper and lower bowels. The intussusception is drawn out by gentle traction through the aperture thus made. The base is then transfixed by two needles armed with ligatures, and the intussusceptum is amputated. The sutures are now passed through the invaginated bowel, tied, and divided. This having been accomplished, the stump is returned and the incision closed. The upper and lower bowels are now secured firmly from slipping from one another by a circular row of Lembert stitches. Paul advises the insertion of a metal spool into the stump of the intussusception, which is secured by a circular ligature. This holds also the mesenteric vessels, and prevents them slipping back into the peritoneal cavity. It should be inserted before the intussusception has been amputated.

FIG. 178.—Intestinal anastomosis in intussusception (Baracz).

The objection to either of these methods is their failure to re-establish immediately a free passage in the bowel. This would be more effectually accomplished by *excision and end-to-end suture;* and this operation could be attempted when the patient's condition was sufficiently good to justify it. The Murphy button might be used if speed were desired, but would be open to the same objections as the Paul method. It would be more applicable to adults than to infants. *Enterostomy* is a last resort, and should be used in such cases only in which the condition is so grave as to preclude the possibility of any other means of giving immediate relief to the obstruction.

Intestinal anastomosis is well adapted to chronic irreducible intus-

susception in the adult, especially in those varieties complicated by the presence of an inoperable tumor, such as a polyp or carcinoma.

Baracz operated in this way upon a case of chronic ileocecal intussusception. Removal of the affected intestine was impossible. The ascending colon and ileum were divided, and united by lateral anastomosis, using plates of Swedish turnip. The excluded coil was closed by suturing the divided efferent ascending colon and the afferent ileum. Recovery was uneventful, and two months after the operation the patient was perfectly well.

Volvulus.—That form of obstruction known as volvulus, or twist, occurs most frequently at the sigmoid flexure; but it may be found in other parts of the colon and in the small intestine.

FIG. 179.—Congenital enlargement of the sigmoid flexure (Fitz's case).

The **causes** of volvulus lie partly in the anatomical condition of the bowel and partly in chronic pathological changes. The twisting of the intestines occurs either about its mesentery or, much less frequently, about its own axis.

Its production requires a definite anatomical arrangement. This may be congenital or may gradually develop during early childhood; but it is not until adult life that volvulus usually occurs,[1] as then the results of long-continued constipation or intestinal irritation added to peculiar conformation make themselves manifest.

[1] Fitz found in an analysis of 34 cases that the greatest number of cases in any decade was between the ages of thirty and forty years.

The sigmoid flexure occupies a much more prominent position in the abdominal cavity of infants and very young children than in adults. Frequently the loop extends across the right inguinal region ("the paradox of Huguier"). Should the condition persist, a long loop of intestine with a long mesentery, more or less narrow at its base, is the result—"congenital enlargement" of the colon (Fig. 179). At the stem of the loop the two layers of bowel run parallel to one another, and then widen out into a somewhat circular arc.

If the colon grows more rapidly than the abdominal and pelvic walls, it falls into numerous folds, which may result in a lengthening of the sigmoid loop ("idiopathic enlargement").

The mesentery of the small intestine may become lengthened in advanced life, owing to the relaxation of the abdominal walls and to the disappearance of fat and other senile changes which take place in the mesentery itself. In large herniæ individual loops of intestine become greatly lengthened.

If now a portion of the bowel is weakened by age or habitual constipation and the peristaltic action has been impaired, a gradual dilatation of the upper layer of the flexure will occur by the accumulations of fecal matter which take place there from time to time. A chronic peritoneal irritation is thus produced, which affects the mesentery quite often at its base. Cicatricial contraction is thus produced and the stem of the loop is still further narrowed. An unusual period of atony, or a temporary paresis produced by violent exercise or a blow may be followed by great dilatation with fecal impaction. The upper segment of the loop becomes heavier than the lower, and a rotation of the loop upon its mesenteric axis occurs. This is not in itself always sufficient to produce intestinal obstruction. The accumulation of gas which now takes place often causes an enormous distention of the loop, so that it becomes firmly fixed in its new position and spontaneous reduction is impossible. The sigmoid flexure may under these conditions fill the abdominal cavity and cause pressure upon the diaphragm

FIG. 180.—Volvulus of the sigmoid flexure (Richardson's case).

and even compression of the lungs (Fig. 180). The formation of adhesions or the pressure upon the pedicle of the volvulus of another elongated loop of bowel may also tend to make the twist permanent. Other portions of the colon may be the seat of volvulus. An unusually long hepatic or splenic flexure may present the necessary anatomi-

cal conditions. Volvulus was found by Fitz to occur in the sigmoid flexure in about 49 per cent. of the cases, and that 87 per cent. of the cases occurred in the large intestine. Volvulus occurs much more rarely in the small intestine. Leichtenstern found in 76 cases 45 twists in the sigmoid flexure, 23 twists in a loop of the ileum, and 8 in a loop of the jejunum and ileum combined. If the root of the mesentery is unusually short and its length is normal, the small intestine is in a condition to undergo twisting as a whole about its mesentery. A single loop of small intestine may also become twisted if the necessary conditions are present. A twisting of the bowel may take place about its own axis. This condition occurs most frequently in the cecum and ascending colon. The exciting cause of volvulus may be trauma.

Thus, Pennington reports a fatal case of twist of the ileum occurring after violent exercise in a girl eighteen years of age. Hawkins mentions the case of a woman who died with symptoms of intestinal obstruction after a slight blow on the abdomen. At the postmortem a figure-of-8 twist of the gut behind the umbilicus was found, which unravelled itself as soon as exposed. Stanley relates a similar accident in a child five years of age, in whom a slight blow on the abdomen was followed by symptoms of acute intestinal obstruction and death in twenty-four hours. At the examination a volvulus 30 inches from the pylorus was discovered. Turner reports a case of volvulus of the small intestine in a boy seven years of age, the result of a fall of 12 feet. It was operated upon successfully. Briddon reports a case of ileus in a girl fifteen years of age, due to an axial rotation of a large lipoma growing in the mesentery.

Instead of twists of a single loop of intestine, we may have two coils wound around one another so as to form a *knot*. The knots thus formed may sometimes be quite intricate. They are usually brought about by the enlargement of the sigmoid flexure with the lower portion of the ileum. Küttner has called attention to the fact that a certain "geographical predisposition" exists. In Russia the length of the small intestine is greater than normal, owing probably to the coarse vegetable diet. König estimates the length of the German small intestine at from 17 to 19 feet; the Russian, from 20 to 27 feet: Grube observed one 56 feet in length.

FIG. 181.—A knot involving ileum with sigmoid flexure.

The formation of a knot is thus explained by Küttner: The twisted sigmoid flexure lies at first in the pelvis, beneath the ileum; as soon as distention begins, it rises up into the abdominal cavity, and in so doing presses the loops of ileum against the bladder. This prevents the loop of ileum from rising. Meanwhile the irritated intestine above, by peristaltic action, forces other coils downward. The imprisoned ileum seeks an outlet beneath the rising volvulus where its pedicle bridges over the sacro-iliac synchondrosis. Nearer the median line the way is blocked by the promontory of the sacrum. Rising up through this outlet, the loop of ileum is enlarged by accession of more intestine, becomes distended, and the knot is tied (Fig. 181). These knots lie most frequently in the neighborhood of the right sacro-iliac synchondrosis. The same kind of a knot can be tied if the loop of ileum is the first to become twisted (König).

Knotting and intertwining may also take place between two loops of small intestine, or between the small intestine and the cecum and ascending colon. According to Leichtenstern, nearly all the cases of knotting occur in males, and between the ages of twenty-four and seventy-three years. Fitz reports 38 cases of volvulus, 26 occurring in males and 12 in females. They run an exceedingly acute course. In many of the cases reported death occurred in forty-eight hours, and in 1 case as early as twelve hours from the beginning of the attack. Thrombosis of the mesenteric vein may occur from constriction and gangrene of the strangulated intestine and hemorrhage into the bowels. One writer reports the passage of a quart of blood on the third day. Abundant serosanguinolent exudation may take place in the peritoneal cavity, which in 1 case, lasting only twenty-four hours, amounted to 6 pounds.

Symptoms.—The symptoms of knots and twists do not differ sufficiently from one another to be considered separately. Volvulus forms by far the greater portion of these forms of intestinal obstruction.

These cases occur usually in middle-aged people, and there is a history of previous constipation or of digestive disturbances. In about one-half the cases there is a sudden onset of pain. Pain is always an early symptom, and is frequently intermittent. It is usually felt in the left iliac fossa or beneath the umbilicus. Tumor is not always observed; but there is frequently an elastic and tympanitic swelling either in the left lower quadrant or at some other point characteristic of the disease. The abdomen finally becomes uniformly tympanitic, and sometimes the tympanites is excessive.

Nausea or vomiting occurs in about three-fifths of the cases. It is not usually an early symptom. Constipation is, of course, present. The seat of the obstruction being lower down in the intestinal canal, tenesmus is probable, and there is the impossibility of introducing water or air beyond the rectum. The passage of blood is not mentioned by many writers, and is probably only an occasional symptom. This affection usually runs a very acute course, and is always fatal unless relieved by operation.

Treatment.—The abdomen should be opened in the median line, and the twisted loop sought. It is better to empty it before attempting reduction of the volvulus. This can be done either by an incision, which is probably the better method, or by the use of a large trocar. In many cases it is wiser to stitch the opening thus made to the abdominal wall, as the condition of the patient may not allow of any further prolongation of the operation. This has the further advantage of preventing the return of the twist, which sometimes happens when gas passes down from the bowel above. It has been suggested to prevent recurrence by stitching the mesentery to the abdominal wall. Finney reports a case of volvulus of the sigmoid flexure in which recur- ˝ three years after it had been relieved by laparotomy. ˝e to a band, which was divided. The patient

˝nvolved may be resected, and the ends or end-to-end sutures. This has been

done successfully by both Richardson and Harrington. In both cases the distended loop filled the abdominal cavity.

Obstruction by Meckel's Diverticulum.—Intestinal diverticula are divided into two classes, the congenital and the acquired. The former are known as Meckel's diverticula, possess true intestinal walls, and are caused by the patency of the omphalomesenteric duct; they are also known as "true" diverticula. The acquired, or false, diverticula are hernial pouches of the intestinal canal. They are frequently simple protrusions of the mucosa through the muscular coat of the intestine, but also sometimes possess a muscular wall. It would be much less confusing if the term diverticulum was abandoned for the acquired form. They do not concern us here, as they have nothing whatever to do with intestinal obstruction.

Meckel's diverticulum owes its origin to the failure of the omphalomesenteric duct to become obliterated. Toward the end of the fourth week of embryonic life of the human fetus the intestine and yolk-sac are in direct communication through the open abdominal wall. After closure of the wall they are connected by the omphalomesenteric duct. Alongside the duct are a corresponding artery and vein.

After the sixth week of embryonic life the vesicle, duct, and vessels wither and are represented by a cord. Should any disturbing influence interfere with this shrinkage, the entire duct may remain open to the umbilicus, or a portion may close and become the fibrous cord. Under ordinary circumstances the cord undergoes fatty degeneration and disappears.

The diverticulum is usually found attached to the lower portion of the ileum—that is, about 3 feet above the ileocecal valve; but it may arise at any point between the duodenum and the cecum. The diverticulum varies also in length.

The cord at the end of the diverticulum may lie free in the abdominal cavity, or it may be attached to the umbilicus, the abdominal wall, to the mesentery, to the ileum, or to the ascending colon. The diverticulum, if there be no cord, may be attached to the omentum, the mesentery, or the ileum. This variation in the point of attachment is, according to Fitz, not caused by inflammatory adhesions, but is due to the persistence of certain of the omphalomesenteric vessels according to the seat and extent of the atrophy.

There are several varieties of strangulation caused by diverticula or omphalomesenteric bands. The most frequent is that already mentioned, in which the bowel is caught under a band with mesenteric attachment. In the case of a long, loose terminal ligament, a coil or knot may be formed by which a loop of intestine may become snared (Fig. 182). This may occur the more easily if the intestinal loop has a narrow mesentery.

Occlusion of the intestine by traction occurs when the ligament is attached to the abdominal wall and becomes so stretched by meteorism that the lower part of the small intestine, especially when fastened down by a short mesentery, is drawn upon and bent at the origin of the diverticulum to such an extent that its lumen is obliterated (Leichtenstern).

Elliot describes a case in which the diverticulum itself became strangulated by a volvulus of the ileum. The diverticulum, having its outer end fixed at the umbilicus, was twisted and strangulated at its base by the turn over of the coil of ileum from which it sprang. Roth described a retention-cyst originating from a diverticulum which became gangrenous from the same cause.

It may be mentioned here that Beach removed successfully a diverticulum communicating both with the ileum and the bladder. The symptoms were those of a tumor situated in the hypogastric region, causing abdominal pain with vesical irritation and offensive urine.

Strangulation by Meckel's diverticulum occurs more frequently in men than in women, and most frequently between the ages of twenty

FIG. 182.—Strangulation by Meckel's diverticulum (Warren Museum).

and thirty years. It has also been observed at earlier ages. The portion of the intestine strangulated is always the ileum. It leads to a fatal result in from four to six days.

Symptoms.—The symptoms are those of acute intestinal obstruction. According to Fitz, in nearly one-half of the cases of vitelline remains previous attacks of pain are recorded. The history of a discharge from the umbilicus, such as was recorded in a case described by Homans, would suggest the presence of a diverticulum. The presence of a tumor or tenderness near the umbilicus should favor the theory of inflamed diverticulum as against the appendix.

Treatment.—Laparotomy is, of course, the only resource. Fitz advises searching the vicinity of the navel and the lower 3 feet of the ileum for these structures, and a careful exploration of the right lower abdominal quadrant. In removing the diverticulum care should be taken in stitching the pedicle, as it often opens directly into the intestinal canal. The vessels should be tied with care, as the diverticulum is supplied by a branch of the mesenteric artery which is t' persistent omphalomesenteric artery, and may be of co   'sle

The **appendix vermiformis** may be the cause of strangulation of the intestine according as its free end becomes attached to the cecum, ileum, or ovary (Fig. 183). Bridges or rings are thus formed into which a loop of intestine may become engaged. The greater frequency of appendicitis in males causes this form of strangulation to occur more frequently in the male sex. The average age at which this occurs is forty years. The strangulated intestine was always the ileum, with one exception, when it was the cecum.

Obstruction by Bands and Adhesions.—The numerous adhesions which are caused by the rapid gluing together of inflamed peritoneal surfaces are, as a rule, absorbed after the inflammatory process which caused them has subsided. They are but a part of nature's provisional repair, so important in its protecting influence over the unaffected portions of the peritoneal cavity. Occasionally, however, a band or adhesion has remained so long or has attained such a size that

FIG. 183.—Strangulation by appendix (Warren Museum).

it becomes thoroughly organized and remains as a permanent structure in the abdominal cavity. It may then become a source of great danger. Such bands are found in various regions of the peritoneal cavity, and vary in size from thread-like strings to stout ligaments, and even to membranous structures. The size and shape often depend upon the movements of the parts to which it is attached.

There are several ways in which such a band may cause obstruction. It may form a bridge under which a loop of intestine may slip and become incarcerated. Such bridges are found on the abdominal walls, especially in the pelvis in the neighborhood of the appendix or uterine appendages; or the two ends may be attached to the mesentery at the base of a loop of intestine, or (Fig. 184) the band may run at right angles to the axis of the intestine from the mesentery to the free border of the bowel. Less frequently such a band may form a loop into which a coil of intestine may slip, and such a coil may the more easily become thus engaged if its limits have been somewhat approximated by adhesions at the root of the mesentery. If one end of such a band should lie free in the abdominal cavity, it may become tied into a knot, much in the same way as has been described in the case of Meckel's diverticulum, and a loop of intestine may thus readily become ʷⁿⁱlated. Such knots are often quite complicated, and are difficult even by a careful dissection.

In some of the more highly organized "pseudoligaments" slits or holes are frequently found into which the bowel may be forced. Obstruction may occur from the presence of a band over which a segment of the bowel may hang like a wet cloth on a line. Flexure or kinking of the intestine may also be produced by adhesion of the same to the abdominal wall, or by traction exerted by a band attached to its free margin. Such tension may be caused by the displacement of some organ to
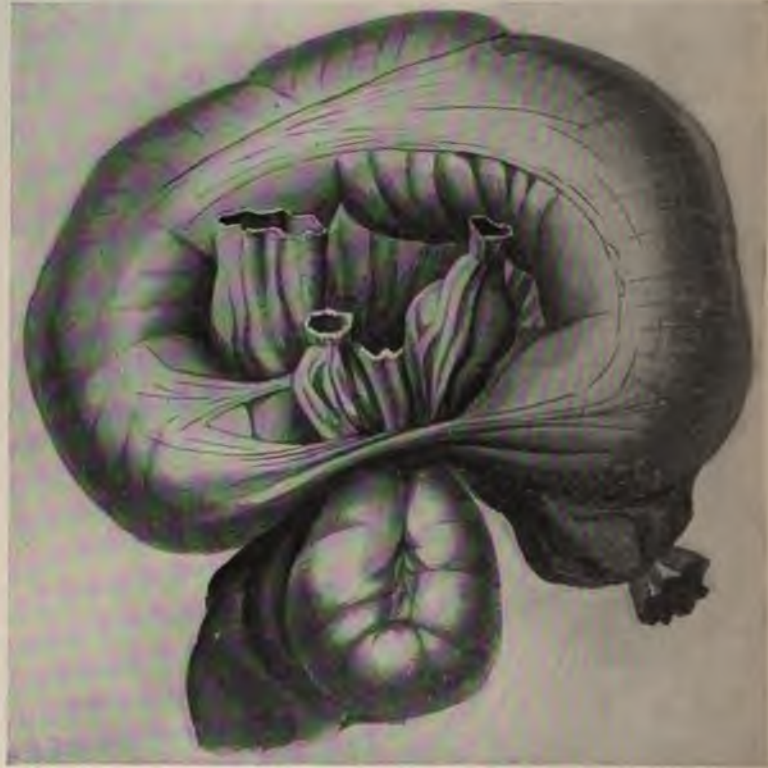
FIG. 184.—Strangulation by a band (Warren Museum).

which the band is attached, such as a floating kidney or an ovarian cyst. Obstruction from pseudoligaments occurs most frequently in persons between twenty and thirty years of age. It may occur in those older than this, but before the age of twenty it is exceedingly rare. It occurs about equally in both sexes, for though adhesions are more frequent in the pelvis in women, strangulation by bands is more common higher up in the abdominal cavity in men, owing to the more frequent existence of hernia, as well as other lesions, in the male sex.

A comparatively fertile source of obstructions are the lesions produced during abdominal operation. Klotze found that in 421 laparotomies this occurred in 5.5 per cent. of the cases. Rohé found that obstructions the result of adhesions caused between 1 and 2 per cent. of the deaths following laparotomy. Tauffer presents statistics of the cases of ileus which have occurred in his clinic during the antiseptic period and since he has employed asepsis. During the first period of 443 operations, 2.25 per cent. were followed by obstruction ; while

during the second period, in 348 operations he has had only 0.57 per cent. of this complication.

Post-operative obstruction of the intestines may be caused in a variety of ways. That form which develops immediately or soon after operation is due usually to paralysis of the intestinal walls, and is known as *ileus paralyticus.* It may be caused by sepsis or injury of the nerve-supply of the muscular coat, or to pressure upon some portion of the canal. According to Adenot, a certain number of these cases are due to pressure upon the left subcostal angle of the colon by distended coils of small intestine; and he advises that this point of the canal should therefore be borne in mind when exploring for obstruction.

Obstruction may, however, occur long after the operation, and may take place in some such way as this—a loop of bowel may become adherent to the operation-wound, such as the incision in the abdominal wound, or the stump of the pedicle. Owing to the amount of inflammation at the time of the operation, this adhesion may become strong and persist, and possibly cicatricial contractions may subsequently occur. The bowel is thus drawn tightly down to the point of adherence, and may be stretched so that kinking or flexure may occur, and a more or less valve-like condition of the bowel at this point become established. The proximal portion of the bowel will gradually become distended, which tends to exaggerate the unnatural condition. An overloading of the bowel may finally lead to complete occlusion. Post-operative obstructions from adhesion occur usually in the small intestine. The course of obstruction by adhesion is usually acute. The fatal end is reached, if relief has not been obtained, in about six days.

The omentum readily adheres to any inflamed spot in the abdominal cavity, exercising a certain protection in this way against infected areas. Adhesions of the omentum are therefore frequent, and this organ furnishes a tangible quota to the list of cases of obstruction. Holes and slits in the omentum frequently occur in the matting-together process which so often occurs, particularly in connection with hernia and local peritonitis. Fork-like processes are often thus developed in adherent omentum with spaces between them. Slits and holes are also observed in the mesentery. They may be congenital or acquired. Trauma is thought to be a not uncommon cause of this lesion. Strangulation may occur beneath the mesentery when it forms the pedicle of the contents of a hernial sac.

Symptoms.—Chronic intestinal disorders may precede the acute attack. There is often a history of several severe attacks of colic, from which the patient has recovered without interference.

In post-operative obstruction these attacks may be situated at or emanate from the seat of the operation-wound. Finally the symptoms of complete obstruction are developed.

Von Wahl calls attention to the local distention of the bowel above the point of obstruction, extending therefrom upward and along the course of the bowel. It forms an elastic swelling which gradually enlarges along the course of the constricted bowel, and is associated with an increased peristaltic movement of the bowel above the obstruction.

Treatment.—The treatment of obstruction by bands differs in no essential from that of obstruction by Meckel's diverticulum. Early operation is demanded. The bands should be carefully tied in two places and then divided between the ligatures. No long band should be allowed to remain lying free in the abdominal cavity. There is

ordinarily not much difficulty in finding the seat of the obstruction. The dilated bowel will surely lead to it. If necessary, the bowels can freely be removed from the abdominal cavity and protected by hot towels. When the tympanites is great it may be necessary to open the bowel at the most distended point. Frequently this will be followed by a sufficient evacuation of gas and fluids to permit of free inspection. A careful hunt should be made in the pelvis and in the right lower quadrant, and also at the splenic flexure of the colon. In very urgent cases the operator must be content to relieve the obstruction by enterotomy, waiting for a more favorable moment to remove the constriction. Occasionally the establishment of an artificial anus will be followed by the passage of feces by the natural way, and the fistula can be allowed to close spontaneously or can be sutured. Such a case occurred in the practice of the writer.

In cases of *post-operative obstruction*, as the constriction is not entirely irremediable, measures should be taken to relieve the symptoms before operating in the less acute cases. In cases of paralytic ileus prompt purgation may prevent the arrest of fecal matter. Klotze recommends washing out the stomach with 4 to 6 quarts of warm salt solution, and following this treatment with catharsis. Copious rectal injections are also recommended.

In case laparotomy is performed, it will be well to make the incision at the side of the old scar if adhesion at this point is suspected. Great care must be taken not to tear the intestine during the process of separation. It is well to divide the adhesion as far from the intestinal wall as possible.

Once the intestine is relieved the lumen will remain free, as no permanent constriction of the bowel has probably occurred.

Obturation of the Intestine.—Plugging of the lumen of the intestinal canal occurs as the result of obstruction by tumors, masses of fecal matter, gall-stones, enteroliths, or foreign substances which have been introduced into the bowel.

Tumors which produce an acute obstruction are those which grow as polypoid masses into the canal, such as a fibroma, lipoma, or myoma. They may drag the wall of the intestine with them, or they may become detached, or they may lead to plugging by fecal accumulation. Malignant disease causes a gradual stenosis of the intestine and gives rise to chronic obstructions.

Gall-stones and Enteroliths.—This form of obstruction is more common in women than in men, most frequently between the ages of fifty and seventy years. Gall-stones are far more common than enteroliths. Of 149 cases collected by Lothrop, in 133 the obstruction was due to gall-stone, and in 16 only to enteroliths. Ten of the 16 enteroliths had a gall-stone of considerable size as a nucleus. Six, therefore, only were pure enteroliths. Gall-stones of considerable size can pass through the biliary ducts, which may become dilated sufficiently to admit the finger; but in order to be of sufficient size to cause obstruction, they must in most cases gain an entrance through a fistulous opening into the duodenum. In rare instances the stone has found its way into the colon and even into the stomach.

In order to produce obstruction the stone need not be of large size.

The average measurement is between 3 and 4 inches in circumference.

The point at which it is likely to become arrested varies greatly. It is most commonly found in the lower ileum, and just above the ileocecal valve, and next in frequency in the jejunum. It has also been found impacted in the duodenum at the ileocecal valve, and in the colon itself. The obstruction is generally due to a single calculus, but in several instances two or more large calculi have been found side by side.

After reaching the lower part of the ileum, it may become arrested without causing complete obstruction, and may for a long time cause symptoms of local irritation, with a localized peritonitis, and finally obstruction from constriction of the intestine. It is during a long sojourn in the intestine that gall-stones become larger by the deposition of fresh layers and assume the character of an enterolith. Such a stone will have a nucleus of radiating cholesterin and a shell composed of ammoniomagnesian phosphate and phosphate of lime. Such stones may occasionally be found lying in a false diverticulum.

When the stone causes complete obstruction, the proximal portion of the gut is found distended and filled with dark-colored intestinal

FIG. 185.—Actual size of the obstructing gall-stone. A smaller stone escaped from the incision in the bowel through which the calculus was removed.

contents containing more or less bile, and sometimes blood in small quantities. The coats of the intestines are more or less thickened according to the duration of the attack. At the point of obstruction the stone is generally firmly grasped by the circular fibers and seldom can be pushed forward, but more often can be moved in the direction whence it came (Figs. 185, 186). The mucous membrane is swollen and congested, and later is ulcerated; but perforation is rare. In two or three instances the calculus has escaped through a perforation into the peritoneal cavity. In most cases in which operations have been

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performed during the first week the pathological changes have been slight, and have rarely been such as to interfere with convalescence. In only one case thus far reported (Birche) was it necessary to resect a portion of the bowel.

Enteroliths are composed of ammoniomagnesian phosphate and magnesia mixed with organic substances and water. They often have a foreign body for a nucleus, such as a piece of bone, or fruit-seed, or
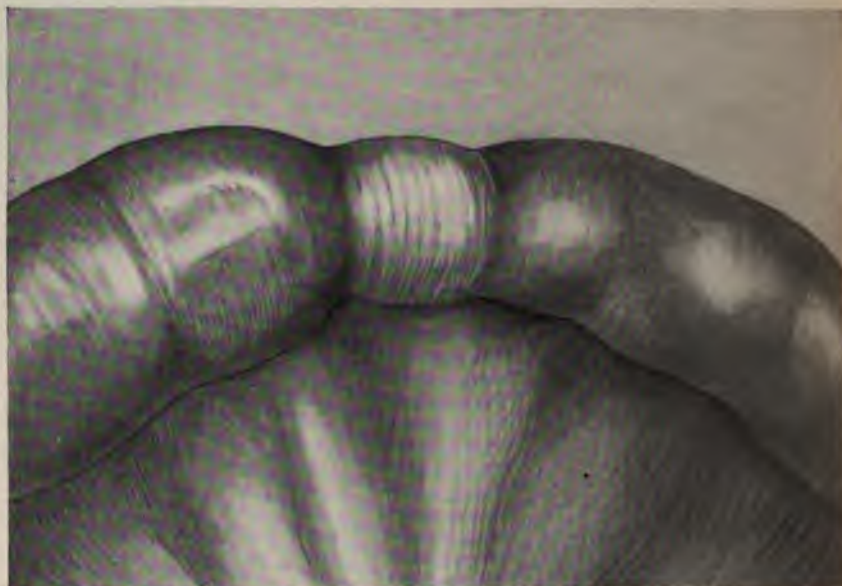
FIG. 186.—Obstruction of the jejunum due to gall-stone, showing the contraction of the muscular fibers of the intestine upon the stone, which is smaller in diameter than the lumen of the gut (Mixter's case; three-quarters size).

a gall-stone. The mineral substances may occasionally be mixed with vegetable material composed of a felted mass of indigestible vegetable fragments. Avenoliths contain oat-stones for a nucleus, and are said to be met with in Scotland among those who live largely on oatmeal. Large stones composed of mineral medicines such as magnesia have been observed, and in one case the enterolith was found to be composed largely of shellac.

Symptoms.—There is no definite group of symptoms characteristic of an acute attack of obstruction from gall-stones. Reliance must therefore be placed upon the previous history of the case. The early symptoms may point to disturbances in the gall-bladder—distress in the right hypochondrium observed after a meal; later, colicky pains in the same region with symptoms of localized peritonitis pointing to the stage of ulceration and passage of the stone into the intestine. Dark blood appears in the stool at this time, and has been attributed to a duodenal ulcer. Relief may have followed the passage of the stone into the duodenum. The passage of gall-stones in the feces is a point about which inquiry should be made. The symptoms may

now be shifted to some other point in the abdomen, and the acute obstruction may be ushered in by severe pain with vomiting or with several days of abdominal distress. The symptoms, as a rule, are not so acute as those of obstruction by bands. Sudden relief may be obtained by passage of the stone through the ileocecal valve. Nausea and vomiting are unusually severe when the seat of the obstruction is in the jejunum. It is more watery the lower the obstruction. Abdominal distention is not marked, especially if the seat of the obstruction be high up in the canal. The general shape of the abdomen and the peristalsis of certain portions of the bowels may throw light upon the seat of the obstruction. The duration of the obstruction is essentially acute.

The chances of a spontaneous cure are fairly good. It is said to occur in about 50 per cent. of all the cases. The average duration of the symptoms in such cases was from two to ten days. In 149 cases collected by Lothrop, the mortality in the nonoperated cases was 63 per cent. The mortality in 23 cases operated upon between 1890 and 1895 was 52 per cent.

Foreign bodies which have been swallowed are, as a rule, evacuated per anum. Certain kinds of substance, such as balls of hair or masses of straw, may remain for a long time—even years—in the stomach or intestine. Obstruction at the ileocecal valve by an accumulation of hair is reported. Eichhorst reports the case of a man addicted to swallowing cherry-stones who was taken with symptoms of obstruction. After the removal of 1010 stones from the rectum the symptoms disappeared. Obstruction by masses of intestinal worms was formerly reported as a matter of comparatively frequent occurrence, but has of late years been doubted. Stepp, however, reports such a mass above the ileocecal valve in a boy who died of ileus.

Fecal impaction, or coprostasis, is caused by a weakened peristaltic action which permits an accumulation of fecal matter at the corresponding portion of the bowel. Below the paralyzed portion of intestine the bowel becomes contracted, and increases the opposition to the advance of the intestinal contents. This condition is sometimes called *ileus paralyticus.* It is found in elderly women with relaxed abdominal parietes and in chronic dyspeptics. It is also sometimes produced by trauma. The collections of feces are usually found in the cecum at the sigmoid flexure, or in the transverse colon. When accumulations occur at the latter point the transverse colon becomes pendulous or M-shaped, and a fecal tumor may be found lying just above the symphysis. These tumors are sometimes enormous, one as large as a child's head being reported in the cecum of an old man. Prolonged impaction may produce stercoral ulcers. These may lead to localized peritonitis, and in very rare instances to perforation.

Kid reports 7 cases of intestinal obstruction due to fecal accumulation associated with displaced kidney. A very slight degree of pressure on the lumen of the large intestine is said to suffice partially to arrest the upward passage of its contents. In these cases the accumulation was in the right half of the colon. The nerve-supply of the right half of the colon and that of the kidney and suprarenal body is derived from the outer side of the solar plexus, and, as the nerves are large and directed horizontally outward, it is supposed that the innervation of the bowel can in this way easily be disturbed.

Treatment in obstruction by gall-stones and enteroliths. Cathartics

have often been administered, as constipation is an early and obstinate symptom. It has been found, however, that cathartics cause the calculus to become more firmly grasped by the increased action of the muscles of the intestine. They are therefore contra-indicated. The medical treatment should be expectant. Opium may be given to relieve the pain and relax the spasm. If after two or three days the calculus has not been passed, laparotomy should be performed. The median incision is advised. The stone having been found, an attempt may be made to push the calculus into the colon or to push it upward to a point above the pathological changes caused by the obstruction. In case of failure to accomplish this, a longitudinal incision should be made in the gut over the stone, opposite the mesenteric attachment. The wound is closed by two parallel rows of Lembert sutures. The treatment of fecal impaction is medical rather than surgical.

Occlusion of the Mesenteric Vessels.—Cases of infarction and gangrene of the intestine due to thrombosis or embolism of the mesenteric vessels are rarely recognized during life.

In embolism of the mesenteric artery there is usually evidence of cardiac and arterial disease. This complication occurs at nearly all periods of life, but principally in middle and advanced age. In 26 cases collected by Watson the largest number occurred between fifty and sixty years. The disease is nearly twice as common in males as in females.

As a result of the infarction produced by plugging the mesenteric artery, the intestine becomes deeply congested and ecchymosed. Its lumen is either contracted and its walls are thickened, or it may be dilated, and spots of beginning gangrene may be seen here and there in the adjacent intestine. The mesentery is rigid and thickened, and studded with extravasations of blood. In other cases, perhaps those less advanced, the affected bowels are of a purplish hue, and the tissue seems soft and friable, tearing easily in the operator's hands. There is a quantity of dark, tar-like blood in the interior of the bowel, and dark bloody serum is found in the peritoneal cavity. In a fatal case of probable embolism operated upon by the writer, there were symptoms of obstruction following intensely severe pain in the shoulder of several days' standing. When the abdomen was opened the larger portion of the intestines seen were cyanotic, and it was extremely difficult to handle them without laceration of the mesentery. Enterotomy was all that could be done. No autopsy was allowed. In Elliot's case the intestine was neither dilated nor contracted at any point. The unhealthy portion was deep red and nearly black, having a slight gangrenous odor: its walls were thickened by the presence of dark blood in the tissue. The peritoneal coat was without luster, and so friable that it was easily torn by handling.

The amount of bowel affected will depend, according to Lothrop, upon the extent of the arterial area involved. Thus, if the embolus was sufficiently large to obstruct the artery near its origin, there would be a sudden loss of blood-supply to the jejunum, ileum, and ascending and transverse colon. If the embolus is arrested in the main trunk beyond the origin of the ileocolic, then only a comparatively small amount of the small intestine would become involved. If the embolus is sufficiently small to find its way into one of the intestinal branches, no serious secondary results need be feared, for the collateral circulation is here very free. It may be for this reason that many emboli from the left heart are arrested here without causing changes sufficient to produce symptoms.

Elliot reports 14 cases of thrombosis of the mesenteric veins. The seat of the lesion in these cases was in the small intestine. The length of the gut involved varied from 40 mm. to 100 cm. ($1\frac{1}{2}$ inches to 3 feet). The associated conditions which have been assigned to the recorded cases are marasmus, cirrhosis of the liver, and thrombophlebitis. Pillet suggests that a bacterial infection of the veins starting from the intestinal canal may be the cause of the phlebitis.

In a case operated upon by the writer, there was a volvulus with infarction of the small intestine. At the autopsy an abscess was found surrounding the gall-bladder, evidently the source of the phlebitis. The volvulus was apparently secondary to the infarction.

The **symptoms** of obstruction which are present do not have anything sufficiently characteristic upon which to base a diagnosis. The previous history of the case may, however, throw some light upon its origin. The existence of cardiac or hepatic disease, or of a hernia, are points to which attention should be called. The first local symptom of the attack is pain of a colicky character, accompanied by vomiting in the majority of cases. The most characteristic symptom is the passage of bloody stools, which are frequently described as consisting of tarry blood, with a carrion odor. Tympanites is present in about one-half of the cases. Elliot calls attention to the possibilities of mistaking this condition for intussusception. The currant-juice discharges seen in the latter condition are probably somewhat lighter in shade and less abundant than the copious tarry stools seen in some cases of embolism or thrombosis. In the beginning of the attack there is often a subnormal temperature, the face is often cyanotic and pinched, and in elderly people especially collapse is often well marked.

FIG. 187.—Resected intestine. Thrombosis of mesenteric vein (Elliot's case).

Treatment.—Laparotomy has been performed by Elliot, McCarthy, Franks, Watson, and Cheever. In all cases the operation was performed without making a diagnosis, and there was a fatal result in all but one of Elliot's cases. The operation usually performed was enterotomy, as the condition of the patient usually precluded a more extended procedure. In 2 cases resection of the intestine was performed. Franks resected 16 inches of gut, with immediate suture.

Death occurred two days later; and at the autopsy it was found that part of the bowel below the line of suture had become gangrenous. Elliot's successful operation was performed for thrombosis of the mesenteric vein in a man twenty-five years of age. He had suffered from a right inguinal hernia which about ten months before had been caught in the ring and was reduced with difficulty. Four feet of small intestine were resected (Fig. 187). Owing to the poor condition of the patient, primary suture of the cut ends was not attempted. The mesenteric borders being carefully united, the open intestine was rapidly stitched into the abdominal wound. Seventeen days later the ends of the bowel were stitched together. A small fistula remained, which was closed by intestinal resection a few months later.

CHAPTER XII.

SURGERY OF THE STOMACH AND INTESTINES.

INJURIES OF THE STOMACH AND INTESTINES.

Rupture or laceration of the stomach or intestine may be produced by severe contusions of the abdomen, such as are caused by blows, kicks, falls, or severe compression, as between the bumpers of railroad cars. The wall of the intestine is more apt to be completely ruptured than is that of the stomach. The laceration of the latter may be partial, involving at times the mucous membrane alone, and at times the serous coat. If the laceration be confined to the lining membrane, gastric hemorrhage will be the main symptom; if it be confined to the serous coat, a local peritonitis may follow; and if the vitality of both the muscular and mucous coats has been impaired, a localized intraperitoneal abscess may follow. If the rupture be complete, which is generally the case when the intestine is injured, leakage of the contents into the peritoneal cavity will follow, and unless checked by operation will result in a fatal peritonitis. In such cases immediate laparotomy is demanded.

A *hematoma* in the mesentery with resulting gangrene of the corresponding section of the intestine occasionally follows a severe contusion of the abdomen. The diagnosis of this condition is difficult; but if the abdominal symptoms excite suspicion, an exploratory laparotomy should be performed.

Penetrating wounds of the stomach or intestines are generally caused by stab- or gunshot-wounds of the abdomen, but may be due to the penetration of sharp fragments of wood or metal, such, for example, as results from impalement on the pickets of a fence. Stab wounds are not so apt to injure the hollow abdominal viscera as are gunshot wounds. If a bullet has penetrated the abdominal cavity, there is a strong probability that one of the hollow viscera has been perforated. The immediate symptoms, consisting of shock and pain, vary greatly. This is due partly to the extent of the hemorrhage and partly to the amount of intestinal contents which have escaped. Signs of collapse may immediately follow the injury, and may be so severe that the patient is practically pulseless. On the other hand they may be but slight, and the first grave symptoms which appear may be those of peritonitis.

Treatment.—Early operation is usually indicated where there is evidence of rupture or perforation. If there be doubt concerning the course of the bullet, the track should be enlarged; and if it is found to penetrate the abdominal cavity directly, it will be safer to make an exploratory laparotomy than to wait for evidences of perforation. Recent wars, however, have shown that where the small-caliber, long-range rifle has been employed, the indications for operative interference

are less urgent, especially if the wound has been received after a long period of fasting. In cases of stab wound it is probably safer to delay opening the abdomen until symptoms arise.

In certain cases the shock may be so great, due at times to hemorrhage and at times to rupture or laceration of the solid viscera, that operation seems unjustifiable. In such patients the surgeon is tempted to wait for a few hours in hopes that active stimulation may produce a favorable reaction. Such delay, however, is apt to be dangerous, and under any circumstances should be of short duration. In a considerable number of such cases the reaction will never follow, on account of the persistent hemorrhage or because of grave injury of one or more of the solid viscera. It must always therefore be borne in mind that there may be a bleeding vessel which requires a ligature, and that the sooner the tear is repaired and the abdomen cleansed, the better will be the patient's chance for recovery. In cases of doubt, it is safer to operate than to delay.

The abdominal incision should be a long one, so that a thorough examination can be made. The perforations of a bullet are apt to be numerous and may be at distant points, as many as 19 having been reported. A certain amount of blood and, perhaps, of the intestinal contents will often be found in the peritoneal cavity, and should be sponged out.

FIG. 188.—Laceration of intestine, showing application of mattress-sutures.

In cases of rupture the tear can often be found without removal of the intestines from the abdominal cavity; and in cases of bullet wounds it is generally wise to avoid complete evisceration; but if it be necessary to withdraw the intestines, they should be kept wrapped up in hot towels. As each coil is withdrawn it is carefully inspected, and as found each perforation or tear should be closed by Lembert or mattress-sutures, the edges being inverted (Fig. 188). When the laceration is extensive or when there are a number of perforations close together, it may be necessary to resect a portion of the intestine. The intestinal coils, as well as the cavity of the abdomen, should be washed with hot saline solution (temperature 110° to 114° F.) and the abdomen closed. Drainage is generally necessary, either by means of a glass tube or by strips of gauze or silk pongee.

STOMACH.

Congenital Malformations.—Congenital stenosis of the pylorus is a lesion of rare occurrence. It may be partial or complete, and is usually associated with hypertrophy of the muscular coat, especially of the circular fibers. The diagnosis is difficult. The treatment should be the prompt performance of a pyloroplasty or a gastro-enterostomy.

Stomachs of abnormal shapes and positions are occasionally encountered. They are apt to be associated with congenital defects of the diaphragm or abdominal wall. Congenital hour-glass stomach has been found in a small number of cases at autopsy. Another rare congenital lesion is prolapse of the mucous membrane of the stomach through the umbilicus. The treatment of these lesions consists in the performance of one or other of the plastic operations described in the later sections.

Foreign bodies will frequently refuse to pass through the pylorus. Dentures are often swallowed, and are apt to remain in the stomach. Accumulations of many and strange articles have been encountered and removed by operation. In one man's stomach the following medley was found: staples, screws, nails, cartridges, knife-blades, etc., to the number of 127, and weighing over 1 pound. From another stomach there was removed a collection of nails, buttons, pieces of glass, etc., weighing nearly 2 pounds.

Treatment.—When it seems evident that the stomach cannot be emptied by gastric lavage, or that the body cannot be persuaded to pass through the pylorus and, by the administration of food which leaves a large residue, be induced to pass harmlessly through the intestinal canal, a gastrotomy should be at once performed, the foreign body removed, and the opening in the stomach closed by suture. The mortality of this procedure has been from 15 to 20 per cent.

Gastrotomy.—This is the opening of the stomach by means of an incision, with closure at the same operation. It is generally performed for the extraction of foreign bodies and for the diagnosis and treatment of intragastric lesions. The abdominal incision, 6 to 12 cm. ($2\frac{3}{8}$ to $4\frac{2}{3}$ inches) long, is generally made in the median line, between the ensiform cartilage and the umbilicus. An incision parallel to and just below the left costal margin will afford better access to the cardiac region of the stomach. In opening the peritoneum the presence or absence of adhesions should be noted. By elevating the edges of the abdominal incision the position and relations of the stomach can be seen. One or more fingers with the thumb are then inserted and the stomach carefully palpated. It should then be drawn gently out of the abdomen and its surface carefully examined for changes in the serous coat or thickening of the gastric wall. Signs of increased congestion of the serous coat are often of value as an indication of the seat of a lesion. After drawing out the stomach the peritoneal cavity should be carefully protected by gauze compresses or sponges. If the operation be done for extraction of a foreign body or for purely exploratory purposes, the opening should be made in the anterior wall. Indeed, this is the best location, unless there be visible abnormalities of the gastric wall which point to a lesion in some other region.

The opening in the stomach, which should be 3 to 5 cm. ($1\frac{1}{4}$ to 2 inches) in length, may be made by pinching up a vertical fold of the gastric wall and cutting across it with the scissors. The larger blood-vessels should be avoided. Often the temporary application of two or three artery-clamps is necessary. Through this opening the interior of the stomach can be carefully inspected and the necessary manipulations accomplished. The opening should then be closed by two rows

of sutures, the first through all the coats, and the second (Lembert) through the serous coats alone. The exterior of the stomach should be washed off with salt solution and the abdominal wound closed. The mortality of the operation will vary from 10 to 20 per cent, according to the local lesion and the general condition of the patient.

Exploratory gastrotomy is often indicated in cases of intractable gastric pain or vomiting. The fact that there exists a gastric lesion which has resisted medical and hygienic treatment is an indication for such an operation. The mortality should be very small, provided the operation be done before the patient has become weakened and emaciated by years of suffering. Unfortunately this is generally the condition of these patients when they are referred to the surgeon, and they are apt to be unfit for any operative procedures.

Ulcer.—The mortality of gastric ulcer is great, being at least 15 per cent. The fatal result is usually due to either perforation or hemorrhage. In addition to the possibility of one or other of these serious complications, there are to be considered also the distressing pain and vomiting from which so many of these patients suffer. In recent years the results of operation for gastric ulcer have been very satisfactory.

The main symptoms which are indications for operative interference are: (1) profuse or repeated hemorrhages; (2) persistent pain; (3) persistent vomiting; (4) signs of perigastritis with adhesions of the stomach to neighboring structures; (5) signs of perforation, either threatened or complete.

The persistence of any one of these symptoms in spite of treatment, especially if accompanied by progressive loss of flesh and strength, is an indication for gastrotomy. It is true that it is not always possible to diagnose absolutely the existence of an ulcer, and the operation may in a sense be regarded as exploratory. As a rule, it is impossible to tell before opening the abdomen on what part of the mucous membrane the ulcer will be found. Pain and localized tenderness are of but little value in this connection. Even after the abdomen has been opened, it is seldom that the location of the ulcer can be determined until the stomach itself has been opened. Its surface, however, should be carefully inspected, and in certain cases adhesions, slight thickening of the gastric wall, or a change in the color of the serous coat may indicate the location of the lesion.

It must be borne in mind that even after the stomach has been opened, it may be difficult to find the ulcer. An aid to the operator may be found in the fact that the great majority of ulcers are situated in the greater curvature and in the pyloric region. It must also be remembered that there are not infrequently two or more ulcers. Through an opening 5 to 6 cm. (2 to $2\frac{1}{2}$ inches) in length in the wall of the stomach its interior can be systematically inspected by inverting its wall piece by piece and bringing its lining membrane opposite, and, if necessary, everting it through the opening. A small electric light is sometimes of assistance.

It is not always the typical depressed ulcer that causes the gravest symptoms. Severe hemorrhage may occur from what appears to be a mere abrasion of the mucous membrane in a region of the stomach, which is generally the seat of a chronic gastritis, as may be seen by the

spongy and congested appearance of its lining membrane. In the midst of this abraded area a bleeding vessel may be found, or a hemorrhage may be started by gentle friction.

Treatment.—The ulcer being found, one of the following plans may be adopted:

(*a*) Simple excision of the diseased mucous membrane and suture of its cut edges. This can be employed when the ulcer is small and superficial, involving the mucous membrane alone.

(*b*) Resection of a part of the gastric wall. This may be necessary when the ulcer is deep, involving the muscular coats, and when there are several within a limited area. It is only in severe cases, however, that it is to be recommended.

(*c*) The performance of a gastro-enterostomy, with or without local treatment of the ulcer. This procedure is appropriate in cases in which a considerable area of the mucous membrane is involved in a chronic catarrhal inflammation with numerous abraded patches or ulcers. In cases of large and deep ulcers, also, it will often be found more satisfactory than resection of a portion of the gastric wall. It has been found that after the lapse of a few months the unhealthy mucous membrane has recovered itself, as is shown by the absence of pain and digestive disturbance. Those symptoms had formerly been caused by the spasmodic contraction of the pylorus, and this had produced a stagnation of food in the stomach, a condition which can no longer exist after the anastomotic opening has been made. The mortality of such operations is about 12 per cent.

Perforation of Gastric Ulcers.—Perforation occurs in about 7 per cent. of the cases of gastric ulcer. Without operative interference the result of direct perforation is almost invariably fatal. By means of operation about 25 per cent. of the cases are saved. The perforation may occur directly into the peritoneal cavity or into an intraperitoneal pouch that has been shut off from the general cavity of the peritoneum by means of adhesions. In the former case, which is most apt to occur with ulcers of the anterior wall, a general peritonitis is at once established. In the latter case an intraperitoneal abscess will form, which will generally at a later period rupture into the general peritoneal cavity unless it be opened by the surgeon.

Treatment.—The prompt performance of a laparotomy is the only salvation for the patient when the perforation has opened into the general cavity of the peritoneum. In certain cases the collapse is so great that the patient dies before an operation can be performed. In other cases, under stimulation a certain amount of reaction will take place in the course of three or four hours, and it is often wise to postpone the operation for this length of time. It must always be remembered, however, that the sooner the abdomen is opened after the ulcer has perforated, the better will be the patient's chance for recovery. A median incision should be made, from 10 to 15 cm. (4 to 6 inches) in length. The perforation is generally found without much difficulty; though it may be necessary to squeeze the stomach, when gas and gastric secretion will be seen to escape. If the patient's condition is desperate, which is apt to be the case, the edges of the perforation should be trimmed and inverted, the opening being closed by Lembert sutures

of silk passed through the serous coat. The peritoneal cavity is cleansed as thoroughly as possible and the abdominal wound closed, with the exception of a space left for drainage, which is generally needed. If the patient's condition will permit of a few minutes' extra time, it is often well to excise the ulcer thoroughly and close the opening as if it were a gastrotomy wound. In some patients—and this is especially found in cases in which the ulcer has slowly perforated and perhaps at first has been shut off from the general peritoneal cavity by adhesions— the gastric wall at the edges of the ulcer and for some distance beyond is so thickened by the products of inflammation that it is impossible to close the perforation by suture, and under such conditions it may be necessary to unite by suture the edges of the opening to the abdominal wall (*gastrostomy*).

When the perforation has been gradual and an intraperitoneal abscess has formed the prognosis is more favorable. The signs of shock are much less severe. Immediate operation is, however, indicated, as the abscess may quickly rupture. The peritoneal cavity should be carefully walled off by gauze or sponges, and the abscess-cavity evacuated, when at its bottom will be found the gastric perforation, which, if possible, should be closed by sutures. This is apt to be difficult, as its edges are generally much thickened, and the opening is not easy to reach on account of inflammatory deposits and adhesions.

Hemorrhage.—This may be caused by an ulcer, growth, impaction of a foreign body, or the swallowing of a leech, or it may be due to constitutional disease. When it is a symptom of the latter the case is not appropriate for operation. Its treatment under the other three conditions is discussed in the other sections of this chapter.

Stricture of the Pylorus, Benign.—In recent years a considerable number of such cases have been subjected to operation, the results of which have been, as a rule, satisfactory. Such strictures may be—

(*a*) Spasmodic, the spasm being either intermittent or more or less persistent; or

(*b*) Organic—a pyloritis, due to hypertrophy of the muscular coat, especially of the circular fibers, with which is usually associated inflammatory tissue deposited in the muscular and submucous coats. This condition is generally the result of long-continued spasm.

(*c*) Cicatricial, generally due to inflammation which has extended from a neighboring ulcer, or to direct cicatrization of a pyloric ulcer, but also occasionally caused by extension of inflammation from adjacent organs, as the bile-ducts or pancreas.

When distinct evidences of pyloric stenosis exist, operative interference is indicated. The most characteristic symptoms of this condition are pain, generally cramp-like in character, and the long continuance of food in the stomach, with the distress resulting from such stagnation.

The abnormal condition of the pylorus may be recognized as soon as it is palpated through the abdominal incision. In cases of cicatricial stenosis it will feel harder and non-elastic and may appear contracted. In cases of pyloritis its bulk and elasticity are increased. In other cases the stricture will not be recognized until the finger has been inserted into the pyloric opening through a gastrotomy wound. If

the ring be found to nip the first joint of an ordinary finger, or if
gentle friction causes it to contract strongly on the finger, the pylorus
can probably be justly blamed, either directly or secondarily, for the
symptoms for which the gastrotomy has been performed. Indeed,
even where some other intragastric lesion exists, if the pyloric ring is
found contracted, it is generally wise to perform some operation for its
relief.

Treatment.—The operations advised for relief of this condition
are : (*a*) pylorodiosis ; (*b*) pyloroplasty ; (*c*) gastro-enterostomy.

Pylorodiosis is the least satisfactory, and is not to be recommended
except in mild cases. The results of the latter two operations are
very satisfactory, and there is but little difference in their mortality.
Gastro-enterostomy is more radical than pyloroplasty and prevents
the possibility of the return of the impediment. It is probably the
better operation of the two, though it has the disadvantage that as a
result regurgitation of bile into the stomach will occasionally take
place. It is, however, to be preferred in many cases, especially when
the pylorus is very much thickened or distorted by cicatricial contrac-
tion or adhesions to neighboring structures, under which conditions
pyloroplasty is difficult and unsatisfactory.

Pylorodiosis is the digital divulsion of the pylorus. There are two
methods :

(*a*) *Loreta's.*—A gastrotomy is performed and the pylorus stretched
by two fingers passed through its orifice. The gastric incision is closed
by sutures. The risk of this procedure is as great as that attending

FIG. 189.—Pyloroplasty : incision in the long axis of the stomach.

pyloroplasty, and it is less efficient in effecting a permanent cure of the
stricture.

(*b*) *Hahn's.*—The stomach is not opened, but one or two fingers

invaginating its anterior wall are thrust through the pyloric canal, which is then digitally dilated. The method is comparatively free from risk; but it is suitable for mild cases only, and it precludes an inspection of the interior of the stomach.

Pyloroplasty, generally known as the Heineke-Mikulicz operation, consists in enlargement of the pyloric opening by means of an incision through its wall in a direction parallel to the long axis of the stomach, and the closure of this by suture at right angles to the original incision.

The incision through all the coats should be from 4 to 6 cm. ($1\frac{1}{2}$ to $2\frac{1}{2}$ inches) in length. A suture or tenaculum inserted in the middle of each lip pulls them apart, so that the slit assumes a lozenge shape, and the edges are then sutured together so that the line of suture will be across the long axis of the stomach, or exactly at right angles to the original incision (Fig. 189).

Interrupted Lembert sutures of silk will generally suffice, though

Fig. 190.—Pyloroplasty : suture of the incision in the opposite direction.

additional security against leakage is given if two rows be employed, the inner passing through the mucous and muscular coats. The mortality of this operation is about 10 per cent. (Fig. 190).

Gastrolysis is a term applied to an operation which consists in dividing the adhesions which fasten the stomach to neighboring structures. Such adhesions are the result of a localized peritonitis due to perigastritis from an ulcer which has partially perforated, or to extension of inflammation from adjacent viscera, as the gall-ducts, pancreas, parietal peritoneum, etc. The adhesions are generally cord- or ribbon-like in character, and can easily be divided between two ligatures. Occasionally, however, a large surface is adherent, as, for instance, with the colon, under which circumstances the separation may be difficult and may necessitate excision of part of the gastric wall.

Gastrorrhaphy, or Gastroplication.—Gastrorrhaphy means suture of the stomach; but the term is generally employed as synonymous

with gastroplication, an operation which consists in diminishing the size of the stomach by means of a fold of its anterior wall. This is folded on itself so that the greater curvature is lifted up to the lesser

FIG. 191.—Adhesion of the stomach to the jejunum, and of the cecum to the transverse colon (Lauenstein).

FIG. 192.—Adhesions between the stomach and the colon, and between the colon and the abdominal wall, etc. (Lauenstein).

curvature, and the two layers of stomach-wall are united by means of three or four rows of interrupted silk sutures. This is shown in Fig. 193, where the stomach is folded at the wavy line, x being sutured to

FIG. 193.—Gastrorrhaphy: showing the points of suture.

FIG. 194.—Gastrorrhaphy: showing the completed operation.

x and o to o, and finally A to A and B to B. The completed operation is shown in Fig. 194.

The posterior wall has in a few cases been treated in a similar manner; but this addition renders the operation very protracted. While in a

few cases the results have been satisfactory, a gastro-enterostomy will generally, in a case of dilated stomach, accomplish a better result.

Gastropexy is an operation which consists in suturing the stomach to the abdominal wall. It is generally performed for the cure of a sagging or displacement of that organ (gastroptosis). Such a condition is generally associated with a laxity of the ligaments and a prolapse of all the abdominal viscera, the so-called Glénard's disease, or enteroptosis. When thus associated, it is doubtful if a suture of the stomach alone will effect a cure unless it be combined with suture of the liver and transverse colon to the anterior abdominal wall, which procedure has in a few cases been followed by benefit.

Gastroplasty is an operation sometimes performed for " hourglass " stomach. The steps of the operation are exactly similar to those of pyloroplasty.

Gastrogastrostomy, or gastro-anastomosis, is another operation performed for this same condition. It consists in making incisions

FIG. 195.—Wölfler's method of gastrogastrostomy for hour-glass stomach, showing the anastomotic openings.

facing each other into the two gastric pouches, and uniting the openings by means of sutures (Figs. 195, 196).

FIG. 196.—Wölfler's gastrogastrostomy, showing the application of the sutures.

Neoplasms.—Benign tumors of the stomach are uncommon. *Myoma* develops in the muscular layer and generally projects inward toward the cavity of the stomach. The size rarely exceeds that of a hen's egg. They may be either sessile or polypoid. In the latter form

they are occasionally found near the pylorus, and may be of such a size as to cause obstruction of the pyloric opening.

Papillomata may grow from any part of the interior of the stomach, but are most often encountered near the pylorus. They may be in the form of patches of rose-colored, highly vascular vegetations, presenting a warty appearance. In other cases a simple pedunculated so-called mucous polypus may be found, varying in size from a pea to a pigeon's egg. Their diagnosis from ulcer is difficult, and can generally be made only after the stomach has been opened, when, if found to be single, the growth should be cut off; but if small and multiple growths are found, they should be destroyed by the cautery, and a gastro-enterostomy performed to prevent their return.

Lipoma, lymphadenoma, adenoma, and *retention-cysts* are very rare; but cases of each have been reported. Among the curiosities may be mentioned calcareous masses which have formed in the mucous membrane as the result of swallowing corrosive sublimate; aneurysms of the mucous membrane, .etc.

Tuberculosis is uncommon, and generally appears in the form of ulcers or as part of a general miliary tuberculosis.

Syphilis occurs even more rarely. It may be one of the causes of gastric ulcers. Gummata have been reported.

Malignant Tumors.—*Carcinoma* occurs as an adenocarcinoma, a medullary carcinoma, a colloid carcinoma, or as scirrhus. It may have its origin in any portion of the stomach, but the pyloric extremity is most frequently affected—in over 60 per cent.

Sarcoma.—Primary is rare; secondary is of more frequent, but still of uncommon, occurrence. The latter is, of course, unsuitable for surgical interference.

Diagnosis.—The early diagnosis of malignant gastric tumor is of the utmost importance to the surgeon. Radical operation, to be of any avail, must be performed at an early stage of the disease. In the later stages one or other of the palliative operations may be performed; but the real benefit of such procedures is often questionable from a humane point of view. In certain cases pronounced benefit and prolongation of life are thus afforded; but, unfortunately, such cases are the exception rather than the rule.

The most valuable symptom is, of course, the recognition of the existence of a tumor. As three-fifths of the gastric tumors occur in the pyloric region, the tumor can be palpated in a considerable number of patients even in the earlier stages. In thin patients a very slight enlargement of the pylorus can be felt if the intestinal tract has been well cleared out, and especially when the stomach has been distended with air. When the abdominal wall is thick and firm a tumor can generally not be felt until it has reached a size which, on account of glandular involvement, excludes the possibility of a radical operation. Reliance must not, however, be placed on the presence or absence of a palpable tumor. If symptoms point to the probability of malignant gastric disease, an exploratory laparotomy should be done at once. Such symptoms are: (*a*) Persistence of pain, vomiting, or other dyspeptic symptoms, accompanied by progressive loss of flesh in patients in middle or advanced life. (*b*) The absence of free hydrochloric acid;

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this symptom is of considerable confirmatory value, but in itself is not pathognomonic. (*c*) An excess of lactic acid is of some diagnostic value, as it is found in about 70 per cent. of all cases of gastric cancer. Unfortunately, however, it is also occasionally found in other conditions.

Operation.—This may be either radical or palliative. Often before opening the abdomen it can be determined that radical operation is impossible on account of the involvement of neighboring structures. In many cases, however, the nature of the operation can be determined only after the hand has been introduced into the abdominal cavity.

The radical operations are pylorectomy and gastrectomy. The latter is a most desperate procedure, and should be attempted only by surgeons who have had large experience in abdominal operations.

Pylorectomy is indicated where the tumor is limited to the pyloric region; where there is no involvement of the glands in the mesentery or omentum, and where there is no evidence of cancer in any other organ.

The palliative operations are gastrostomy and gastro-enterostomy. Before either of these operations is done the true conditions should be explained to the patient, and he should be allowed to decide whether or not he wishes to have his life prolonged under the circumstances. The risk of either of these operations should not be great unless the vitality of the patient is very low. In cases in which the obstruction in the esophagus is producing slow starvation, gastrostomy offers a reasonable probability that suffering will be diminished and life be prolonged. In patients in whom the pylorus is obstructed, so that frequent and persistent vomiting renders life unendurable, a still greater measure of relief can be promised by means of gastro-enterostomy. In cases, however, in which there is a more or less general involvement of the stomach, either operation promises so little relief that it is scarcely justifiable.

Gastrostomy is the establishment of a permanent opening into the stomach. Its object is to prevent death from starvation. It is indicated in stenosis of the esophagus due to cicatricial contraction, or to a neoplasm of either the esophagus, the cardiac region of the stomach, or the mediastinum.

The mortality of gastrostomy for malignant disease is about 30 per cent.; for non-malignant disease, about 10 per cent.

Until recent years the operation consisted of suture of the stomach to the abdominal wall and a direct opening into its cavity, either immediately or after the lapse of a few days, when adhesions had shut off the general peritoneal cavity. This method has been generally abandoned for one or other of the recent ingenious procedures by means of which a valve, spur, or sphincter is formed which prevents the escape of the gastric contents. Of these, the best are the methods known as those of Ssabanajew-Franck, Witzel, Senn, and Kader.

Von Hacker's operation is very simple, and consists in drawing the stomach through a slit which has been made by blunt dissection in the left rectus muscle, whose fibers are supposed to act as a sphincter. Unfortunately, however, this sphincteric action is generally inefficient.

Ssabanajew-Franck Method (Figs. 197, 198).—An oblique incision from 5 to 8 cm. (2 to $3\frac{1}{4}$ inches) in length is made a finger's breadth

below and parallel to the border of the left ribs. Through this a cone of the stomach is drawn out, and a silk retention-suture passed through the serous and muscular coats at the apex of the cone. The base of the cone as it passes through the abdominal incision is sutured to the

FIG. 197.   FIG. 198.
FIGS. 197, 198.—Ssabanajew-Franck's method of gastrostomy.

parietal peritoneum. A second incision parallel to the first is then made about 2 cm. ($\frac{3}{4}$ inch) above the free border of the ribs. The bridge of skin between the two incisions is dissected up from the under-lying muscle, and under this is drawn by its thread the cone of the
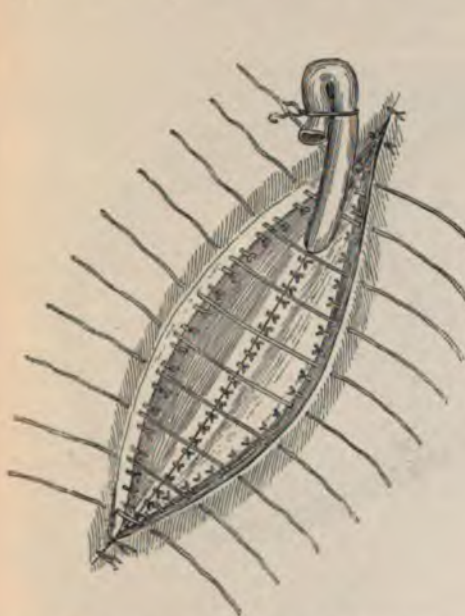
FIG. 199.—Witzel's method of gastrostomy: tube in position; sutures ready to close abdominal wall.

FIG. 200.—Witzel's method of gastrostomy: tube in position; sutures ready to tie.

stomach till its apex projects through the upper incision. A small opening is made and a tube inserted into the stomach at the apex of the cone, the edges of which are sutured to the skin. The original skin-

incision is then closed by suture. By means of the valve-like action of
the bridge of skin and the obliquity of the canal leakage is not apt to
occur.

Witzel's Method (Figs. 199, 200).—In this operation a long, oblique
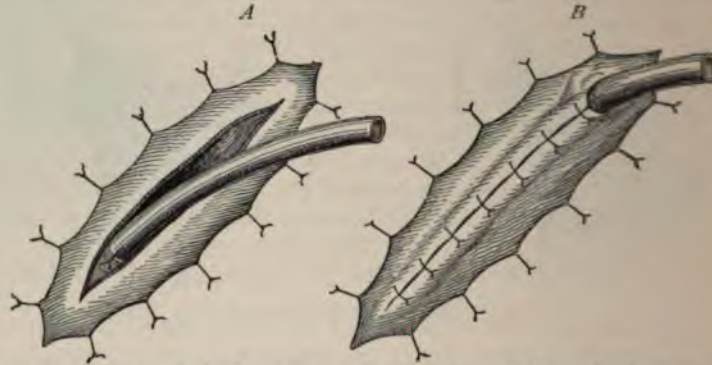
FIG. 201.—Marwedel's method of gastrostomy: *A*, tube inserted through the mucous membrane; *B*, tube covered by suturing the muscular and serous coats over it.

canal is formed by folding the stomach-wall over a tube. A skin-inci-
sion 5 to 8 cm. (2 to $3\frac{1}{4}$ inches) in length is made below and parallel to
the free border of the left ribs. The left rectus is divided in a vertical

FIG. 202.—Pylorectomy: showing the application of clamps and lines of section.

direction, and the transversalis in a lateral direction. The peritoneum is
opened by a vertical incision and the stomach is in part drawn out.
An opening of a size to admit a No. 25 (F.) catheter is made in its

anterior wall, rather nearer the cardiac extremity. The projecting portion of the catheter or rubber tube, the end of which has been inserted into the stomach, is laid on its anterior wall, leading upward toward the lesser curvature. Five to 6 cm. (2 to $2\frac{1}{2}$ inches) of the tube are then buried by folding over it two pleats of the stomach-wall, by means of Lembert sutures introduced through the serous and muscular coats. The stomach is then replaced, and its wall, just external to the folds which bury the tube, sutured to the parietal peritoneum, and the abdominal wound, except where the tube emerges, is closed by suture.

Kader's method resembles somewhat that of Witzel's. The tube is inserted vertically into the stomach. By means of Lembert sutures two pleats of the stomach-wall are sutured to each other in each side of the tube, thus depressing into the cavity of the stomach a funnel-shaped projection of its wall. The stomach beyond these folds is sutured to the parietal peritoneum and the transversalis fascia.

Marwedel's Method (Fig. 201).—The oblique incision is employed. The parietal peritoneum is sutured to the skin and a fold of the stomach-wall is drawn out and sutured to the edge of the abdominal incision. For a distance of 5 cm. (2 inches) the serous and muscular coats of the gastric wall are split in a vertical direction. At the lower extremity of this incision the mucous coat is opened by a small incision and a tube inserted into the stomach and fastened by a suture. The serous and muscular coats which have been dissected back for some distance are then sutured over the tube. The tube is thus buried in the gastric wall, between the muscular and mucous coats, for a distance of 5 cm. (2 inches).

Closure of Gastric Fistula.—A gastric fistula may result from perforation of ulcers, from traumatism as the result of operations, or from the swallowing of foreign bodies. They generally close spontaneously. If they decline to do so, it is best to open the peritoneal cavity, separate the adhesions which join the stomach to the abdominal wall, and close the gastric opening by suture.

Pylorectomy, or the excision of the pyloric extremity of the stomach, is indicated in cases of malignant disease in which the neoplasm is limited to the pyloric region. The involvement of neighboring organs contra-indicates this operation; and the presence of enlarged glands in the mesentery renders its propriety doubtful unless they are few in number, close to the stomach, and can be removed.

The mortality has been great principally because the patients have not been sent to the surgeon until their strength has become exhausted by months of pain or vomiting. It has varied from 20 to 70 per cent., but it is constantly diminishing.

Preliminary to the operation the stomach should be washed out by lavage. The median abdominal incision, from 10 to 20 cm. (4 to 8 inches) in length, is made mainly above the umbilicus. The stomach should be well drawn out of the abdomen, and gauze compresses or sponges packed about it. The points at which the stomach and duodenum are to be divided are selected. This should be from 3 to 5 cm. ($1\frac{1}{4}$ to 2 inches) beyond the disease. The greater and lesser omentum corresponding to the part to be removed are grasped by two or more

large clamps and divided. If preferred, ligatures can be at once employed. The stomach just proximal to the point chosen for section is grasped by two large clamps. The duodenum is likewise clamped. The diseased pylorus is then cut away with scissors. It may be necessary to strip the duodenum from the pancreas for a short distance in order to reach healthy tissue.

The next step consists in the union of the intestine to the stomach. This may be accomplished by one of two methods :

(*a*) An end-to-end anastomosis of the duodenum to the stomach. As the opening in the stomach is necessarily much larger than that in the intestine, the former is closed by suture until the size of the opening corresponds to that of the duodenum. This is accomplished by two rows of silk sutures ; the inner embracing all the coats, and the outer being Lembert sutures passing through the serous coat alone and inverting the edges already sutured (Fig. 203).

(*b*) Closure by suture of the opening in the stomach and anastomosis of the open end of the duodenum into the posterior wall of the stomach either by suture or the Murphy button.

(*c*) Closure of the stomach and duodenum by suture and anastomosis of the jejunum with the posterior wall of the stomach (Figs. 204, 205).

Gastrectomy, or extirpation of the stomach, is justifiable only in the most exceptional cases in which the cancer involves the greater part of and is limited to that organ.

FIG. 203.—Pylorectomy : cut end of duodenum united to stomach.

The duodenum is divided well below the growth, between two clamps. The pyloric extremity of the stomach is seized and drawn outward. A clamp is placed on the greater omentum and another on the gastrohepatic or lesser omentum, which are then divided. The gastrophrenic and gastrosplenic ligaments are treated in the same manner. Several large veins are generally encountered between the spleen and cardiac pouch. The stomach is drawn downward and cut off from the esophagus at the cardiac orifice. If this part of the stomach is healthy, it is well to leave sufficient of its wall for the introduction of sutures, as the wall of the esophagus is brittle. Either the cut end of the duodenum or a loop of jejunum is then drawn up and united to the esophagus by means of a Murphy button or by suture.

Gastro-enterostomy is an operation which consists in the establishment of an anastomotic opening between the stomach and the intestine. According to the portion of intestine selected for such union, the operation is called gastroduodenostomy, gastrojejunostomy, gastro-ileostomy, etc. It is indicated in any condition in which an impediment exists to the proper egress of the gastric contents into the intestine, or after excision of the pylorus or a portion of the small intestine. It is most often employed for obstruction in the pyloric region, and under such circumstances the jejunum is the portion of intestine generally selected. Such obstruction may be benign in character or malignant. The results of this operation when done for benign disease are especially favorable, the mortality being less than 10 per cent. When done

for malignant disease the mortality, on account of the wretched condition of such patients, is greater—about 30 per cent.

The jejunum is the portion of intestine best fitted to unite with the stomach. The recognition of this is not always easy, and it is important that no mistake should be made; as, for example, if the lower part of the ileum should be selected by a mistake which has been too often made, death will be apt to result. The surest and the easiest method for the identification of this portion of intestine is as follows: The transverse colon is drawn upward out of the abdomen; the mesocolon is stretched, and the finger of the operator is carried downward toward its base from left to right; when passing under the arch of the ligament of Treitz a loop of intestine will be found which is positively jejunum.

It is important that after the intestine is united to the stomach their peristaltic movements should be in the same direction; and, as a guide,

FIG. 204.—Finger picking up jejunum as it emerges under the ligament of Treitz.

it is well on locating the jejunum to indicate its proper relationship by means of threads passed through its mesentery. The next step is the selection of the part of the stomach-wall in which the anastomotic opening is to be made. Originally this was the anterior wall. Such anastomoses, however, often resulted in compression of the colon by the jejunum and in regurgitation of bile into the stomach, on account of the sagging downward of the jejunum on each side of the anastomosis until its branches became almost parallel. To remedy these two evils there are many methods; but the best is probably that of von Hacker, which consists in the anastomosis of the jejunum with the *posterior*

wall of the stomach. To accomplish this a vertical slit is torn in the transverse mesocolon (Fig. 204), and through this and into the cavity of the lesser omentum is passed the loop of jejunum, where it is readily adjusted to the posterior gastric wall. Generally, union may be effected practically outside of the abdomen, the transverse colon being drawn upward and the posterior wall of the stomach

FIG. 205.—Posterior gastro-enterostomy: showing suture of jejunum to stomach, a fold of which has been drawn through the slit in the transverse mesocolon.

downward through the slit in this structure, and the anastomosis made without risk of soiling the peritoneal cavity. It is well after the anastomosis is completed to fasten the edges of the slit in the mesocolon to the serous coat of the stomach by two or three sutures.

The union can be made by either sutures or the Murphy button. With the button it can be more rapidly effected. Occasionally, however, even after posterior gastro-enterostomy, the button will fall into the stomach and remain in that organ. With sutures a larger anastomotic opening can be made. If time is an important element, the button should be used. In other cases the choice must rest with the operator, as the results of each method are excellent.

If sutures are to be employed, the union is made as follows: A

coil of jejunum 8 to 10 cm. ($3\frac{1}{4}$ to 4 inches) in length and a corresponding portion of the stomach-wall are held in approximation by an assistant; or the forceps of Laplace may be employed for this purpose. The serous coats of each are sewed together by a continuous Lembert silk suture for a distance of 6 to 8 cm. ($2\frac{1}{2}$ to $3\frac{1}{4}$ inches), the thread with needle attached being left long. This forms the posterior border of the opening (Fig. 205). Corresponding incisions are then made into the stomach and intestine, about $\frac{1}{12}$ inch in front of the line of suture. The cut edges of stomach and intestine are then sutured together around the entire opening, the sutures passing through all the coats of each. The union is completed by carrying the row of serous Lembert sutures around the anterior border of the opening. Silk is the best material for the suture, which may be continuous; but it is wise to tie the thread at several points. An ordinary cambric needle is generally the best, though at times a curved intestinal needle may be more convenient.

INTESTINES.

Foreign Bodies.—Foreign bodies which have passed through the pylorus generally continue their passage through the intestinal canal without obstruction. Occasionally, however, on account of change of position, swelling, sharp projections, or agglutination with the intestinal contents, their onward progress is hindered, and an obstruction, partial or complete, may result. Not only may they obstruct the lumen of the intestine, but at their point of arrest ulceration and perforation of the intestinal wall may occur. Enteroliths, gall-stones, fruit-pits, masses of hair, and any of the innumerable objects swallowed, for various reasons may cause obstruction. Perforation also is sometimes due to such bodies; but is more apt to be caused by sharp objects, such as pins, knives, forks, sharp fragments of wood, glass, etc. The perforation rarely takes place directly into the cavity of the peritoneum, but is more apt to occur gradually into an intraperitoneal pouch which has been formed by protective adhesions. An abscess rapidly develops, which, unless opened by operation, may work its way to the surface, or may rupture into one of the hollow viscera or into the general cavity of the peritoneum.

The **treatment** of obstruction or perforation due to a foreign body is immediate operation. If the symptoms point to a perforation into the general peritoneal cavity, a medium laparotomy should be performed, the foreign body removed, and the edges of the perforation trimmed, inverted, and closed by one or two rows of Lembert sutures passed through the serous coat. The abdominal cavity should be thoroughly cleansed with hot saline solution, properly drained, and closed by suture.

If an *intraperitoneal abscess* has formed, the incision should be directly over the mass. The abscess should be cautiously opened, the peritoneal cavity having been carefully protected by gauze pads or sponges. The cavity should be cleansed and the perforation closed.

When the symptoms are those of intestinal obstruction the foreign body must be removed by an enterotomy.

Enterotomy is an operation which consists of an incision into the intestine and its closure at the same operation. It is usually employed for removal of foreign bodies or benign tumors, or for exploratory purposes. The particular portion of intestine may be designated by the terms jejunotomy, colotomy, etc. A median incision is generally the best, unless it be positively known at what point the intestine is to be opened. The loop of intestine is, if possible, drawn outside the abdomen and surrounded by gauze pads or sponges. The coil selected for incision is emptied by squeezing back its contents with the finger and thumb. To prevent its refilling intestinal clamps may be employed, or, what is more simple, the fingers of an assistant. The intestine is opened by an incision in its long axis, opposite the mesenteric attachment. This may be made by a knife or by snipping a transverse fold with scissors. The foreign body is then removed, or, if there be an intra-intestinal lesion, it is treated. The opening is closed by two rows of silk sutures; the inner passing through either the mucous coats alone or all the coats, and the outer being Lembert sutures in the serous coat.

Perforating Typhoid Ulcer.—The mortality from the perforation of ulcers in the course of typhoid fever is about 6 per cent. The outcome is death in more than 90 per cent. of the cases. The diagnosis is often difficult. The most significant symptoms are sudden and severe pain with tenderness in the right iliac fossa, accompanied by a fall in the temperature and signs of collapse. In three-fourths of the cases these symptoms appear suddenly; in the other fourth their onset is more latent or even may be entirely unnoticed. Nearly 100 cases of perforation have been subjected to operation, with a mortality of about 80 per cent. The dangers of operation are very great, mainly on account of the low vitality of the patient; but also because to the dangers of peritonitis and shock are added those of the sepsis and exhaustion of the original disease.

Operation.—The shock of perforation is generally so great that operation must be postponed for some hours. Unfortunately, in the majority of cases recovery from this state of collapse does not follow, and the condition of the patients is never such as to warrant operative interference. In order to give any hope of success the operation should be done within twenty hours of the time of perforation, and if possible should be done within twelve hours. A median incision is best, if the perforation has taken place directly into the peritoneal cavity, as a general septic peritonitis will already have commenced. If the seat of perforation has been shut off by adhesions and an unruptured intraperitoneal abscess has formed, a lateral incision over the inflammatory mass is generally more convenient.

The perforation is not always easy to find. In the majority of cases it is situated in the ileum. It must be remembered, however, that occasionally there is more than one perforation. When found, the edges should be turned in and the opening closed by interrupted Lembert sutures or mattress-sutures which pass through the serous coat alone (Fig. 188). In some cases the ulcers will be so extensive and numerous that suture is not practicable, and it may be necessary to excise the diseased portion of intestine and either form an artificial

anus by fastening the end of the proximal portion to the skin, or unite the two ends by a Murphy button. The latter method, however, is but seldom advisable, as the patient's condition is such that every minute saved is of the greatest importance, and the intestinal wall is apt to be so impaired in vitality that the chances of union of the two ends are not favorable.

The peritoneal cavity should be carefully cleansed by sponging and irrigation with *hot* saline solution. Drainage is advisable. If the perforation has opened into an intraperitoneal pouch, this should be opened and cleansed and the perforation treated as above described.

Hemorrhage due to typhoid ulcer is one of the most fatal complications of that fever. It is but rarely that surgical treatment is advisable. In exceptional cases it may be justifiable, but it will always be a very desperate and almost hopeless procedure. The source of the hemorrhage is very difficult to find. After the ileum has been opened by an incision the bleeding ulcer, if found, should be cauterized or its edges drawn together by suture. It is advisable to make an artificial anus rather than to close the intestinal wound.

Tuberculosis.—Tuberculosis of the intestine occurs generally in the form of ulceration with secondary involvement of the lymphatic glands. Its most common seat is the lower part of the ileum. Perforation occasionally occurs. It is generally gradual, resulting in an intraperitoneal abscess. The treatment is the same as that which has been described for typhoid ulceration. Several successful excisions of the cecum for tuberculosis have been performed.

An intraperitoneal abscess may form without perforation from suppuration of the tubercular glands. The tendency of such is to work its way to the surface; but it should be opened as soon as a diagnosis has been made.

Cicatrization of tubercular ulcers may so narrow the caliber of the intestine as to produce obstruction. Under such circumstances the performance of one or other of the plastic operations will be indicated.

Syphilis has in a few instances apparently been the cause of intestinal obstruction. Excluding the rectum, the seat of such lesions is most often in the upper part of the small intestine. All the coats are thickened, but the submucous layer is the first and the most extensively involved.

Ulcer of the Duodenum.—The pathology, symptomatology, and treatment of ulcer of the duodenum are similar to those of gastric ulcer. The indications for operative interference are the same. Perforation is the most serious complication, and demands immediate operation. It will generally be difficult to determine whether it be a gastric or duodenal ulcer which has perforated; but in either case laparotomy, closure of the perforation, and cleansing of the peritoneal cavity are indicated.

CHRONIC INTESTINAL OBSTRUCTION.

The division of cases of intestinal obstruction into acute and chronic must necessarily be more or less arbitrary. Obstruction due to foreign bodies has already been considered (page 377). The other causes of

intestinal obstruction to be considered in this chapter are—1. Inflammation; 2. Benign tumors; 3. Malignant tumors.

Inflammatory Obstruction.—The treatment of obstruction by bands, kinks, etc., has been already discussed (page 351). Among the most difficult cases of intestinal obstruction to relieve are those due to old inflammatory trouble of the peritoneum, which has generally been accompanied by the formation of pus. The adhesions of the intestinal coils are due to the vigorous attempt on the part of nature to shut off the general cavity of the peritoneum from the abscess, which may have burrowed extensively in order to find an easy outlet. As the result intestinal coils are found twisted, doubled on themselves, and agglutinated to each other to such an extent that it is often most difficult to separate the adhesions and to remedy the obstruction which has been produced.

Treatment.—Generally a painstaking separation of adhesions with division of omental and mesenteric bands will result in a partial restoration at least of the intestinal channel. At times, however, the agglutination is so excessive that an unobstructed canal cannot be obtained by these procedures; and in such cases it may be necessary partially or completely to exclude the agglutinated and contracted coils from the intestinal circulation by means of an anastomosis (page 383). In other cases it may be best to perform an intestinal resection.

A partial obstruction, so extensive as to demand operation for its relief, has in a few cases been produced in the sigmoid flexure and upper rectum by an enormous inflammatory deposit in and around the coats of the intestine. This has generally extended from the pelvic organs in the female. Time and judicious treatment will usually cause the absorption of this mass, but in a few cases operative relief has been demanded. This has been either in the nature of a colostomy or an intestinal resection. The obstruction, especially if due to cicatrization of an ulcer in the small intestine, may involve a very limited area only. In such a case it may be relieved by a comparatively simple operation—i. e.

Enteroplasty.—This is similar to pyloroplasty, and the technic of the operation is the same.

Obstruction by benign or innocent **tumors** of the intestine are uncommon. Fibromata and myomata develop at times to a considerable size and may cause complete obstruction. They may also project as polypi into the intestinal canal, and as such are among the predisposing causes of intussusception. Papillomata and adenomata occasionally occur, though the latter are apt to be malignant in character. Lipomata and cysts are among the rare forms which have been found in the large intestine.

Obstruction by Malignant Tumors.—*Sarcoma* is a form of neoplasm but rarely found in either the large or the small intestine. It may, however, occur in any portion, either primarily or secondarily from metastasis or from extension from a neighboring organ, as the pancreas. The cecum seems to be a favorite spot, and several resections of this portion of the intestine have been successfully performed for sarcoma.

Carcinoma may occur at any point of the small or large intestine,

either primarily or secondarily. Its most favorite seats, however, are the cecum and sigmoid flexure. The symptoms are apt to begin insidiously, and the disease has generally been in progress for some time before a diagnosis is made. They are those of intestinal indigestion, or "biliousness." There may be either diarrhea or constipation; but most frequently these conditions alternate. Occasionally blood appears in the stools. The progress of the disease is often slow, and pain is generally not complained of until other symptoms of obstruction appear; indeed, it is usually only after the intestinal caliber has become at least partially obstructed that a diagnosis is made. When this occurs constipation becomes more marked, and is accompanied by abdominal distention and often severe pain. Unfortunately a tumor can be seldom felt before the disease has become far advanced. At this time ascites may appear. Emaciation with loss of strength is progressive, though often it is not marked until late in the course of the disease. Cachexia is often absent in the earlier stages.

The **diagnosis** cannot be positively made until a tumor be felt. The favorable moment for operation is then, however, generally past. The existence in a person past middle life of symptoms of increasing intestinal indigestion and difficulty in defecation, accompanied, in spite of treatment, by loss of flesh and strength, is a sufficient indication for an exploratory laparotomy. With such symptoms the diagnosis of probable malignant disease will generally be verified by the operation.

Treatment.—As soon as a diagnosis is made, or as soon as the surgeon is convinced that the symptoms are so suspicious that an exploration is indicated, laparotomy should be performed. The operation should be either radical or palliative. The former consists in extirpation of visible or tangible disease. Unfortunately the impossibility of this will be often determined before the abdomen is opened, on account of the size of the tumor and its adhesions. If it be positive that radical operation is out of the question, it is perhaps wiser to delay until symptoms of obstruction appear. In many cases, however, the nature of the operation will be in doubt until the abdomen has been opened. If it be then found that the growth cannot be removed, it will be generally well to anticipate future obstruction and perform one of the palliative operations, either an entero-enterostomy or an enterostomy (colostomy).

Enterectomy consists in the excision of a portion of intestine. It may be performed for traumatism, as laceration or gunshot wounds, for diseases such as tuberculosis, for stricture or gangrene, and for neoplasms. The abdominal incision should generally be median. The affected intestinal loop is, if possible, drawn outside the abdomen, which is carefully protected by compresses of gauze or sponges. The contents of the portion of intestine involved, and for several inches on each side of the proposed line of operation, are squeezed out. This portion is kept empty by one of several methods. The most simple is pressure by the fingers of an assistant. If he be skilful, this is a most satisfactory method; if not, one of the mechanical devices must be employed. A strip of tape or firm gauze passed through a hole in the mesentery and tied around the intestine is a serviceable method. A safety-pin fastened over a strip of sponge which encircles the gut is

another. Several ingenious and valuable clamps are used for this purpose.

The clamps should be applied at such a distance from the disease that the section of the gut can be made at a point where it seems perfectly healthy. If done for a malignant growth, this should be at least 5 cm. (2 inches) beyond the disease. The intestine is divided by knife or scissors. A considerable length of intestine can be removed with safety. Over 20 feet of small intestine have been successfully excised, as have also the cecum and entire colon. A few bleeding vessels may need the temporary application of artery-clamps.

If a considerable portion of intestine has been removed, or if the operation be done for malignant disease, a wedge-shaped portion of the mesentery should be removed, including all suspicious glands. The vessels are clamped and ligatured. If the disease be non-malignant and if but a few inches be removed, it is better not to excise any part of the mesentery, as there is always the risk that some of the blood-vessels needed for the proper supply of the ends which are to be united may be severed.

After excision of the diseased portion has been accomplished, the future steps of the operation will depend on whether an artificial anus is to be established or the continuity of the intestinal canal re-established by means of an anastomosis of the cut ends. In the former case the operation is termed an *enterostomy ;* in the latter, an *entero-anastomosis.* The term *enterorrhaphy* is applied more particularly to *suture* of the divided ends. The term resection is employed when a portion of intestine is excised and the divided ends united.

Resection of Intestine.—The diseased portion of intestine having been excised, the union of the divided ends (entero-anastomosis) is accomplished by one or other of the following methods:

FIG. 206.—Lateral implantation.

(*a*) *End-to-end anastomosis,* the open ends being united directly to each other. The term circular enterorrhaphy is employed when sutures alone are used (Figs. 208–210).

(*b*) *Lateral anastomosis* or approximation, where a lateral opening is made between two coils of intestine which are fastened by suture side to side (Figs. 211, 212).

(*c*) *Lateral implantation,* where an open end of intestine is fastened to a lateral opening in another portion of intestine (see Fig. 206).

The union between intestines can be accomplished by means of sutures alone or with the aid of some mechanical device, such as plates, rings, buttons, bobbins, etc.

Union by Suture.—(*a*) *Circular Enterorrhaphy, or End-to-end Anastomosis.*—Many ingenious methods of suture are employed. There is none better than the one known as the Czerny-Lembert suture. Figs. 207–209 illustrate the method of applying this suture as generally

understood in this country. It will be seen that there are two rows. The inner (Fig. 207) unites the mucous membrane alone, the knots,
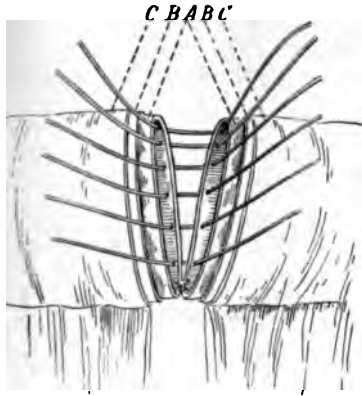
FIG. 207.—Circular enterorrhaphy: showing inner row of sutures through mucous membrane.
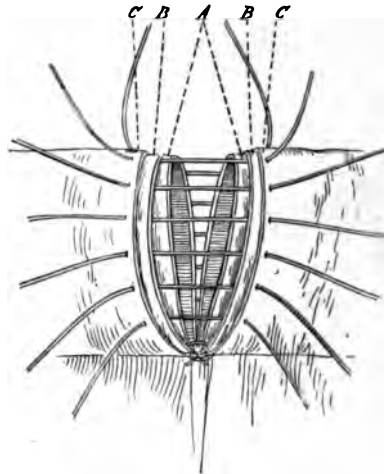
FIG. 208.—Circular enterorrhaphy: showing inner row of sutures through serous and muscular coats.

with the exception of the last, being tied inside the gut, and the outer unites the serous and part of the muscular coats (Fig. 209), but leaves out the mucous coat.
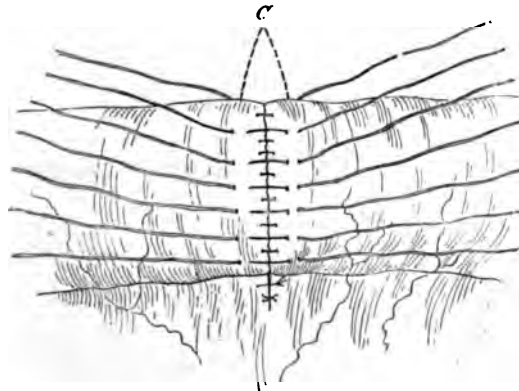
FIG. 209.—Circular enterorrhaphy: showing outer row of Lembert sutures (inner row of Fig. 208 tied).

Figs. 208, 209 illustrate the method as usually employed in Europe. There are two rows: the inner (the Czerny) (Fig. 208) passes through the muscular and serous coats, and the outer (Lembert) (Fig. 209) through the serous coat alone.

Instead of either of these plans, two rows of Lembert sutures (Fig. 209) may be employed. The mattress-suture is another excellent method.

(*b*) *Lateral Anastomosis.*—The intestines to be united are approxi-

mated parallel to each other for a distance of 10 to 12 cm. (4 to 4¾ inches). If there be an open end, this is closed by inversion of the edges and one or two rows of Lembert sutures. The parallel coils are then united to each other for a distance of 6 to 8 cm. (2½ to 3¼ inches) by a Lembert continuous suture (Fig. 205). This forms the outer layer of one side of the opening, and it can be at this time curved around each end. The thread is left long with the needle attached. Openings in each intestinal wall are then made opposite each other
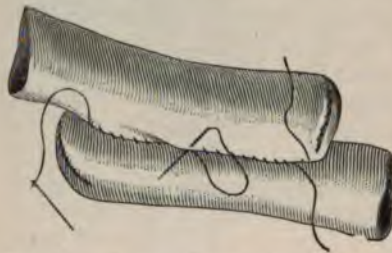
FIG. 210.—Suturing intestines in apposition before incision (Abbe).

FIG. 211.—Showing the 4-inch incision and sewing of the edges (Abbe).

from 4 to 7 cm. (1½ to 2¾ inches) in length. The edges of the openings are united to each other by a continuous overhand suture which passes through all the coats of each side (Figs. 210, 211; also Fig. 206). The first row of Lembert sutures is then continued around the opening until it joins the point at which it started. By some surgeons
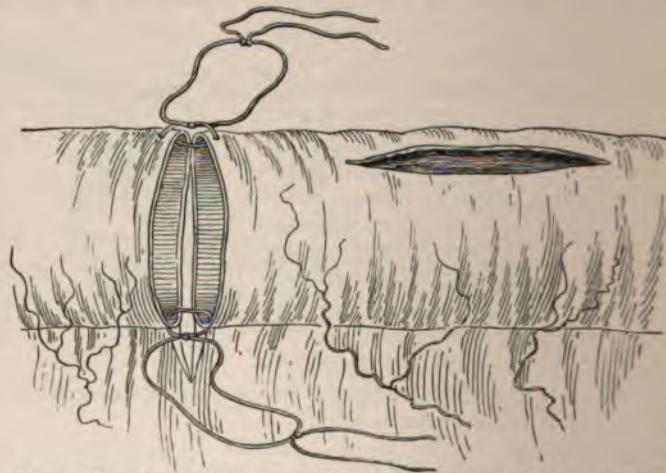
FIG. 212.—Maunsell's method of enterorrhaphy: showing intestinal ends approximated by temporary sutures, and the longitudinal slit.

it is thought safer to employ two rows of Lembert sutures. Under any circumstances, if the line of suture seems weak, it is well to reinforce it by a few additional interrupted sutures.

(c) *Lateral implantation* can be accomplished by either of the above methods.

Maunsell's method is a very excellent one for either end-to-end union or lateral implantation. The open intestinal ends are approximated by two *temporary* sutures of silk, left long, which pass through all the coats, one at the mesenteric attachment and the other opposite (Fig. 212). A longitudinal slit about 4 cm. ($1\frac{1}{2}$ inches) long is then made in the wall of one of the portions of intestine (the larger should be selected), about 3 cm. ($1\frac{1}{4}$ inches) away from the point of section and opposite the mesenteric attachment. Through this temporary lateral opening the ends to be united are drawn by means of the two long sutures, and while the coats of these two ends are held in approximation by an assistant, they are united by a suture which passes through all their coats, peritoneum being united to peritoneum. The intestinal
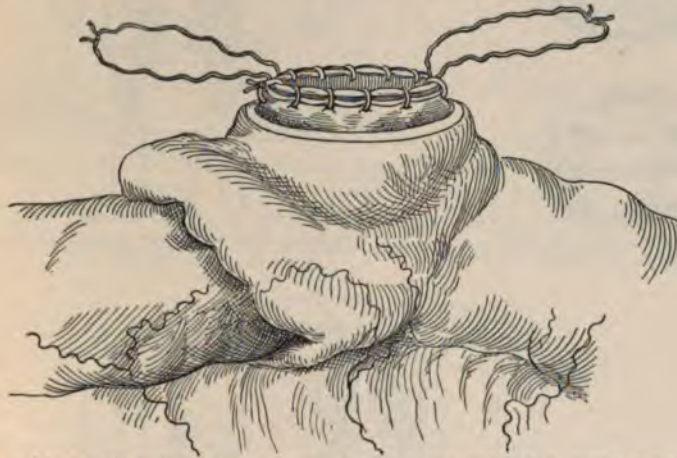
FIG. 213.—Maunsell's method of enterorrhaphy: showing ends of intestine drawn through slit and sutured longitudinally.

ends thus united are then withdrawn, and the lateral opening closed by Lembert sutures.

FIG. 214.—Maunsell's method of enterorrhaphy: intestinal ends united and longitudinal slit closed by sutures.

Union by Mechanical Aids.—A great variety of ingenious devices and appliances have been employed. Senn's bone plates are perhaps the best known, and are still used by some surgeons, though in recent years the Murphy button has largely replaced all other mechanical

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aids. Many of the other appliances, however, are useful, as catgut rings, potato or turnip plates or buttons, decalcified bone bobbins, inflatable rubber bags, etc.

FIG. 215.—Murphy button : *A*, open ; *B*, closed.
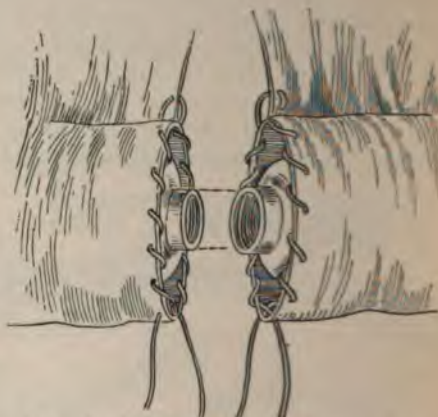
FIG. 216.—Murphy buttons in place ; sutures ready to be tied.
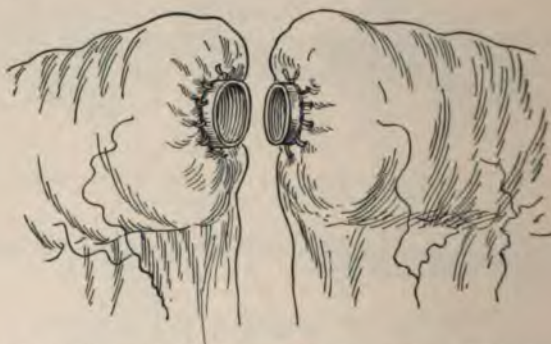
FIG. 217.—Intestinal ends tied around buttons by purse-string suture.

Murphy buttons are of various sizes, according to the caliber of the desired opening. Fig. 216 shows the running thread for circular enter-

FIG. 218.—Suture and incision in lateral approximation.

orrhaphy, and Fig. 217 for lateral approximation. One half of the button is inserted into each open end, and the purse-string suture tied

(Figs. 216, 217). The two halves of the button are then locked and the union is completed. A few Lembert sutures can be introduced, if desired, for reinforcement of the line of union.

A simple device is the *potato button*, or *bobbin of Landerer*. It can be made in a few minutes by the surgeon or one of his assistants. Its method of introduction resembles that of the Murphy button: the drawing
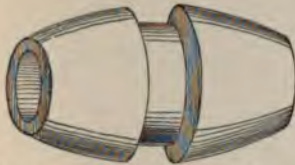
FIG. 219.—Landerer's potato button.

FIG. 220.—Application of the suture.

thread, the introduction of each half into the open ends of intestine, the tightening of the sutures which keeps in approximation the serous coats. A few additional Lembert sutures should, however, be inserted around the line of union. Similar to this is the method by means of the decalcified *bobbins of Mayo-Robson* and *Allingham*. Another
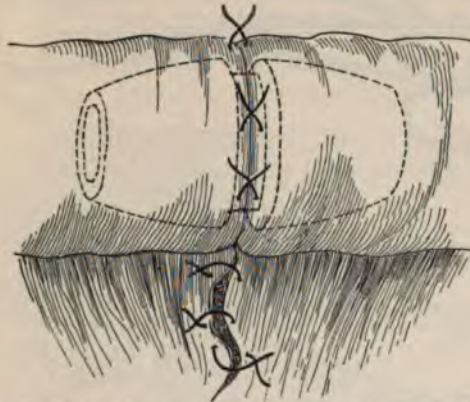
FIG. 221.—Intestinal ends closed; button in place; additional Lembert sutures.

method which has recently been advocated by Halsted and others is the use of an *inflatable rubber cylinder*, which, in its collapsed state, is inserted within the intestine, the ends of the latter being held together by two or three sutures. Lembert or mattress-sutures are then employed to unite the serous coats, and the bag is withdrawn before they are tied.

The latest method is that devised by Laplace. In end-to-end anastomosis four fixation-sutures are applied at the cardinal points, uniting the ends to be approximated. The forceps (Figs. 223–225) are then introduced between the sutures. In lateral anastomosis each blade is passed into a slit made in the portions of intestine to be approximated (Figs. 226, 227). After the suture is completed, one
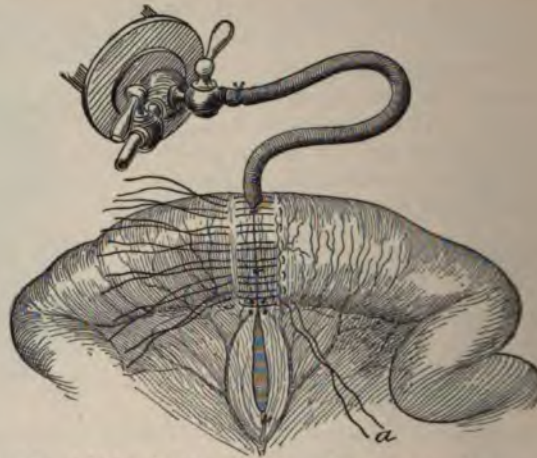
FIG. 222.—Use of Halsted's inflated rubber cylinder in circular enterorrhaphy.

FIG. 223.—The hemostatic forceps bent into semi-circles and clamped to hold them together (Laplace).

FIG. 224.—The forceps clamped together and opened as two rings (Laplace).

FIG. 225.—The forceps closed (Laplace).

half of the forceps is removed at a time through a small, unsutured opening (Figs. 228, 229).

FIG. 226.—End-to-end anastomosis: the forceps is introduced between two sutures, and one blade is made to pass into each gut (Laplace).

Choice of Method.—This will depend much on the personal skill and experience of the operator. The choice at the present day is

FIG. 227.—End-to-end anastomosis: the forceps is clamped, bringing serous membrane to serous membrane; sutures have been applied circularly (Laplace).

practically narrowed down to union by sutures alone and union with the aid of the Murphy button. Union by means of the button can, as

FIG. 228.—End-to-end anastomosis: one half of the forceps is being removed from small unsutured opening.

FIG. 229.—End-to-end anastomosis: removal of second half of forceps.

a rule, be more rapidly accomplished. With a dextrous operator, however, the difference in time will be but slight. Accidents, such as perforation and gangrene, are perhaps more apt to occur with the use

the button than with the suture. Union with the button is more easily accomplished, and this method should, as a rule, be employed when saving of time is of essential importance.

As a rule, an end-to-end union is the best when the openings of the ends are approximately of the same caliber. Lateral anastomosis may be employed in uniting intestines where the size of one much exceeds that of the other. It is also serviceable in cases in which it is desired to exclude some portion of the intestinal tract. It can be accomplished by means of either sutures alone or with the aid of the Murphy button. With the latter there is a limitation to the size of the anastomotic opening.

Lateral implantation is often suitable when it is desired to unite ends of intestine which vary greatly in caliber. This is difficult to accomplish by means of end-to-end union, as for example after an excision of the cecum there remains the open end of the ileum to join with the bulky colon. In such a case lateral implantation is an excellent method. The choice between this and lateral anastomosis will largely depend on the local conditions. Generally, however, the implantation by either Maunsell's method or with the aid of a Murphy button will be more easily accomplished and probably more satisfactory.

Enterostomy consists in the establishment of a permanent opening into the intestine. This term is often limited to an opening in the small intestine. It is usually formed by suturing some part of the intestine to the abdominal wall. It may act as a mouth or as an anus. It acts as the former, for example, if the jejunum is opened to prevent starvation when a gastro-enterostomy is not possible because of extensive disease of the stomach. It acts as an anus when the colon is opened on account of obstruction. According to the portions of intestine opened, the operation is called jejunostomy, ileostomy, colostomy etc.

Jejunostomy may perhaps be indicated in certain cases of cancer when it is of the utmost importance to prolong life; but the propriety of this procedure must be always questionable. As a temporary measure in cases of traumatism it may also be occasionally indicated. The steps of the operation are similar to those of colostomy.

Ileostomy is indicated in cases of obstruction in the cecum which cannot be removed by radical operation. If possible, however, it is generally preferable to anastomose the ileum with some part of the colon. The technic is the same as that of colostomy.

In cases of obstruction, it is advisable to select a part of the intestine as low down as possible. This cannot always be accomplished, however, on account of the enormous distention of the intestine and the collapsed condition of the patient. In such a case the most accessible loop of distended bowel should be sutured to the abdominal wall and opened. When possible, however, the artificial anus should be situated in the large intestine. If it be in the jejunum or high up in the ileum, sufficient absorption will not take place, and, as a consequence, in the course of a few weeks the patient generally dies of malnutrition. Even when the anus is situated in the lower part of the ileum, it is often difficult properly to maintain nutrition.

The point of selection for an artificial anus is the descending colon,

as low down as possible. If the obstruction be located in the splenic flexure—a not uncommon seat for carcinoma—it will be necessary to open either the ascending or the transverse colon.

Colostomy.—The artificial anus is generally made either in the left or right inguinal region. Inguinal colostomy, whether it be left or right, is distinctly superior to lumbar colostomy, an operation which at the present day is but seldom performed.

Inguinal Colostomy.—The steps of this operation are the same whether it be made on the left or the right side. An incision from 4 to 7 cm. ($1\frac{1}{2}$ to $2\frac{3}{4}$ inches) in length is made parallel to Poupart's ligament and 3 cm. ($1\frac{1}{4}$ inches) above it, the center being opposite the junction of the outer and middle thirds of the ligament. The incision may be carried through all the layers of the abdomen; but it is often preferable, on account of the resulting sphincteric action, after division of the external oblique muscle to separate the fibers of the internal oblique by blunt dissection, which will be in a direction nearly at right angles to the line of incision in the external muscle. After the peritoneum is opened, the finger passed in at the outer angle of the wound and drawn toward the median line will generally feel the sigmoid flexure at once, if it be on the left side. This can be easily recognized from small intestine by the appendices epiploicæ and sacculation due to the longitudinal bands. A loop of the large intestine is drawn out of the wound. If it be the sigmoid flexure, it should be gently drawn downward, so as to prevent the formation of loose folds of bowel on the proximal side of the new anus. The farther steps will then depend on the lesion which has demanded the formation of the artificial anus and on the condition of the patient. If the opening in the bowel is intended to be temporary only, a spur should not be made; if it be intended as a permanent anus, an attempt should be made to form a spur. In the former case the intestine is sutured to the parietal peritoneum by an interrupted or continuous catgut suture which passes through the serous coat alone. If the obstruction be absolute and immediate relief is needed, the intestine must be immediately opened by a vertical incision about 2 cm. ($\frac{3}{4}$ inch) in length. Should delay be permissible, however, the opening of the gut can be advantageously postponed for two or three days, when the intestine will have become agglutinated to the parietal peritoneum and can be opened without danger of leakage into the peritoneal cavity. The edges of the opening in the gut should be sutured to the skin.

If, on the other hand, it is intended that the anus be permanent, a spur should be formed, so that none of the fecal contents will pass beyond it and perhaps act as an irritant to the diseased bowel below, or accumulate in a pocket and cause poisoning by absorption. The steps of the operation will here also depend on the necessity for immediate opening of the gut. If this can safely be postponed for a day or two, the simplest method is to transfix the mesentery, after drawing out a loop of gut, by a glass rod or metal pin, the ends of which rest on the surface of the abdomen. It is generally well to fasten the serous coat of the bowel to the parietal peritoneum by a couple of sutures, to prevent protrusion in case of excessive vomiting. In a day or two adhesions will have formed between the intestine and parietal perito-

neum, and an opening can be safely made and the edges sutured to the skin. If, on the other hand, the intestine must be opened at once, the parallel branches of the protruding loop are sutured together at their mesenteric border for a distance of 3 to 5 cm. ($1\frac{1}{4}$ to 2 inches), and each branch at its point of protrusion carefully sutured to the parietal peritoneum. It can then be opened at once (see Fig. 230). Unless the distention is very great, the intestine does not generally empty itself to any great extent until several hours have elapsed after the opening has been made.

Unfortunately the spur is very often inefficient, and for this reason it is sometimes advisable to divide the intestine completely at a point several inches above the obstruction or disease. The distal end is then closed by inversion of its edges by means of one or two rows of Lembert sutures, and the open end of the proximal portion is fastened in the incision in the abdominal wall.

It will occasionally be found that on account of extreme distention of the intestines and thinning of their wall the introduction of sutures is not possible. Under these circumstances it may be necessary to draw

FIG. 230.—Inguinal colostomy: colon sutured and ready to be opened.

a loop out of the abdominal incision, or as close to it as possible, and wall it off from the general cavity of the peritoneum by abundant gauze packing. It can then be opened without much risk if the first gush of intestinal contents is carefully handled.

Colopexy is an operation which consists in suturing some part of the colon to the abdominal wall. It is indicated in some cases of enteroptosis, the transverse colon being sutured to the anterior abdominal wall just below the ensiform cartilage, and in cases of extreme prolapse of the rectum the sigmoid flexure being drawn upward and sutured in the left iliac or lumbar region. A few Lembert or mattress-sutures unite the serous coat of the bowel to the parietal peritoneum and abdominal muscles.

are of purely mechanical origin, and are not evidences of infection and inflammation. That such hyperemia and hypersecretion take place in other organs of the body as a result of mechanical or chemical stimulation is beyond question; that the same conditions may arise in the appendix without the intervention of bacterial infection is certainly probable.

The *symptoms* of appendicular colic usually begin suddenly with a sharp attack of pain, which may be general or referred to almost any region of the abdomen—very frequently to the epigastric region—but which sooner or later becomes localized in the right iliac fossa. These attacks of pain will be early associated with nausea or even persistent vomiting, and with considerable prostration; but, nevertheless, the patient does not appear seriously ill. The temperature and pulse show no marked change from the normal, except that the temperature may be from ½ to 1 degree below the normal. These symptoms may last for from one to twenty-four hours; or the pain may persist after the vomiting has ceased, and the point-tenderness may persist for a day or two after the acute symptoms have subsided. Recurrence of the attacks at short intervals is the rule.

Catarrhal Appendicitis.—In this variety of the disease the conditions of hyperemia and oversecretion exist as in the previous variety; but here they constitute the disease itself, and are not merely passive sequelæ of a pre-existing condition of another type. Here the above-mentioned conditions do not arise from mechanical causes alone, but are the result of catarrhal inflammation involving the mucous lining of the appendix and due to some form of infection. The large amount of lymphoid tissue contained in the mucosa of the appendix renders it prone to such infection. This inflammation and the consequent hyperemia result in swelling of the mucosa with its lymphoid tissue and a narrowing of the lumen of the tube. This narrowing will be specially marked at the cecal junction or at the location of normal or pathological kinks or strictures; and the oversecretion which occurs will lead to a dilatation of the appendix beyond the point of constriction. The secretions thus confined under pressure become a favorable medium for the growth and multiplication of bacteria which under normal conditions in the intestinal canal would remain quiescent and harmless.

Such an attack will be accompanied by pain and vomiting, with elevation of temperature and increased rapidity of the pulse. The pain is at first general, or may be referred to the epigastrium; but in a few hours it becomes well localized in the right fossa, and pressure at or very near McBurney's point will elicit a marked degree of tenderness. The vomiting is usually persistent, the vomited matter being at first composed of food, later of mucus, and occasionally bile. The temperature ranges between the normal point and 103° F., with a pulse of from 90 to 120. There is some rigidity of the abdominal wall upon the right side, but the abdomen elsewhere is generally soft. A certain amount of prostration exists at the height of the attack, but this is rapidly recovered from; and if the swelling in the mucosa subsides, all the symptoms will abate, and in from one to three or four days the patient will seem to have entirely recovered from the disease.

PLATE 4.

Appendicitis: *a*, appendix perforated near the cecum; removed on the third day; *b*, gangrenous appendix; *c*, appendix obliterated except at the tip; removed for recurring attacks of pain; *d*, partially obliterated appendix with fistulous opening causing frequent relapses; removed at second operation; *e*, hydro-appendix due to obliteration near cecum.
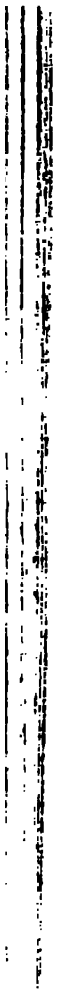
Suppurative Appendicitis.—In this form of the disease there exists within the wall of the appendix one or many foci of suppurative inflammation. In the former case the process will be localized at one point in the tube; while in the latter a more or less extensive portion of the whole appendix will be involved. All the coats of the appendix are included in the inflammation, but not to the same degree. The infection takes place from within through the mucosa, and the infection atrium occurs most usually at a constriction of the lumen of the tube, and is due to one or more of the various forms of traumatism spoken of previously in the discussion of Etiology. These suppurative attacks are often preceded by one or more attacks of appendicular colic or of catarrhal appendicitis, or by successive attacks of both. The traumatism gives rise to a solution of continuity in the mucous membrane, which may be only epithelial in depth or only of microscopic extent, but which in either case will allow of the entrance of bacteria, which set in motion a suppurative form of inflammation. As a result, small abscesses form in the wall of the appendix, and as the mucous membrane over them breaks down, more or less deep ulcerations are produced. The secretion from the mucous membrane will be increased in amount and much altered in quality, and will become mixed with the pus and detritus from the ulceration; and the cavity of the appendix will come to contain an amount of mucopurulent fluid sufficient to cause a high degree of distention of the organ, so that the appendix will constitute an abscess-cavity. The peritoneal covering will be involved in the inflammation, which, if sufficiently intense, will be accompanied by a plastic exudate. If the process stops here and recovery takes place, there is left an appendix free from adhesions, but with a thickened wall and an organized stricture occupying the position of the previous inflammation. Such an appendix will never return to a normal condition, and will be liable to subsequent disease. If, however, the inflammatory process continues, the appendicular peritonitis will excite, through bacteria or their toxins, an inflammation in the serous covering of a viscus or of the abdominal wall, or of both, which may be contiguous to the appendix. Then, the plastic exudate taking place, adhesion between these peritoneal surfaces will occur (adhesive peritonitis). By such extension of the peritonitis the appendix will become buried in coils of intestine, or between intestine and abdominal wall; and should the infiltration now subside, the appendix will be bound down and adherent through organization of the exudate into more or less permanent connective-tissue bands. The permanency of these adhesions will depend largely upon how much continuous irritation is kept up by the altered appendix. If, however, the infective process continues, a suppurative inflammation will be excited outside the appendix and within the area of the exudate, and a peri-appendicular abscess will result. Such an abscess will be sharply confined by the adhesions around it; and it is even now possible for the active process to terminate and the contents of the encapsulated abscess to undergo gradual absorption or caseation. If, however, the process actively continues, the abscess will become progressively larger, but with a tendency to remain limited by adhesions formed by the advancing peritonitis on the outskirts of the actively infective process. The direction

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in which an abscess will extend depends upon the position and direction of the appendix (Hartley). It may extend across the pelvis into the left fossa, down into the pelvis, upward and inward among the coils of ileum, or upward along the right side of the cecum, reaching even to the diaphragm. If extending and not opened by the surgeon, the abscess may rupture into the cecum, externally through the abdominal wall, or into the rectum, bladder, or vagina; or in the ascending variety it may cause a perihepatitis and abscess of the liver, or it may open into the pleural cavity; or, after causing an adhesive inflammation between the costal and pulmonary pleura, it may open into a bronchus. The abscess, however, may break through the confines of the adhesive peritonitis and so cause a general septic inflammation of the whole serous membrane. Rupture through the abdominal wall rarely takes place spontaneously (McBurney, Park).

Such an attack of appendicitis will begin suddenly, with pain referred to the epigastric or umbilical region of the abdomen, nausea and vomiting occurring simultaneously with the appearance of the pain. The temperature, which is rarely ushered in by chills, and almost never by a distinct rigor, ranges from 100° to 103° F. The pulse at the beginning of the attack is full and about 100; but occasionally after an attack of vomiting it may be more rapid. After from six to twelve hours the pain is localized in the right iliac fossa; the temperature usually remains elevated, and the pulse more rapid and bounding than normal. Pressure over the base of the appendix elicits well-marked point-tenderness; the abdomen is tympanitic, and distinct muscular resistance is noted upon the affected side. If the inflammation does not extend beyond the appendix-wall, no tumor will be felt; but the dilated appendix itself may in some cases be readily made out. In order to feel the appendix strong pressure should be made with the hand, at first in the median line, and then moved outward and downward toward the iliac spine, sufficient pressure being maintained to identify structures which become interposed between the hand and the posterior abdominal wall.

Should the inflammation subside at this point in the attack, all symptoms will gradually disappear within a few days, the point-tenderness, which is the most persistent of the signs, remaining for a longer period. If adhesive peritonitis takes place the symptoms persist, and there is added the local sign of a tumor in the right fossa, caused by the adherent mass of coils of intestine. Where an abscess forms and extends the tumor is seen to grow larger, and the symptoms of septic intoxication of a varying degree of severity will present themselves. If not surgically treated, such an abscess may yet rarely undergo spontaneous cure by encapsulation of the abscess, with gradual caseation and absorption of its contents; or the abscess may rupture and discharge its contents externally or into some viscus; or the rupture may occur into the free abdominal cavity, with septic general peritonitis and death; or the patient may die of prolonged sepsis and exhaustion.

Perforative Appendicitis.—When perforation of the appendix takes place after protective adhesions have been formed by a previous attack of inflammation, the contents of the appendix will escape into the mass of connective-tissue adhesions rather slowly, exciting a suppurative inflammation and resulting in the formation of a peri-appendicular

abscess, whose course and symptoms will be similar to those already described under Suppurative Appendicitis. If the current attack has caused the adhesions, abscess will follow the perforation as before; but its growth will be more rapid because of the smaller resistance offered by the fresh adhesions. These cases may start as comparatively mild attacks, and will be apparently doing well when a sudden rise of temperature with some collapse and increased pulse-rate show that perforation has taken place. When the perforating ulceration has been caused by a fecal concretion, this concretion will be found within the lumen of the appendix, opposite the opening made, or will have escaped through the opening and be found loose in the abscess-cavity. Such an attack cannot undergo cure by encapsulation and absorption. Perforation may occur without the presence of a fecal concretion, in which case the current attack of inflammation has caused a swelling of the coats of the appendix that has rendered a previously existing stricture impervious. Hypersecretion and overdistention, with stretching and thinning of the parietes of the appendix, may then cause a rupture of the wall, with leakage of the contents into the surrounding mass of connective tissue.

In the second variety of perforative appendicitis either there have been no previous attacks of inflammation or they have left no permanent adhesions, and the present attack has given rise to none; but the appendix is strictured, and on the distal side of the stricture there may have been formed a concretion made up of food-detritus and desquamated epithelium, and pressure by this concretion may cause an ulceration of the appendix-wall, which is likely to be accompanied by few, if any, symptoms. Or the perforation may be the result of overdistention of the lumen of the appendix. With the rupture and the escape of the contents of the appendix into the free abdominal cavity there will occur sudden pain of an excruciating character, referred to the epigastrium, vomiting, fever, rapid pulse, board-like abdomen which is tympanitic on percussion, collapse, and all the symptoms of a general purulent peritonitis with septic intoxication.

Gangrenous Appendicitis.—In this variety of the disease the bacterial infection is sufficiently intense to cause a rapid necrosis of the appendix in whole or in part, with immediate infection of the general peritoneum, frequently resulting in death of the individual from septic intoxication. It has been claimed that septic thrombosis of the appendicular artery is the cause of this rapid gangrene *en masse* of the appendix, but recent investigators have failed to find either thrombosis or endarteritis of the afferent vessel of the appendix (Hawkins). Very little exudate is found in the peritoneal cavity in these cases, and this is of a serosanguinolent character. The reaction of the tissues in the immediate neighborhood of the wound, in such of these cases as have been operated upon, is especially striking. No attempt at limiting adhesions takes place, and the wound will be almost dry or will contain at the bottom, between the coils of gut, a small amount of thin, brownish-colored fluid possessing an offensive characteristic odor. No granulations appear anywhere upon the wound-surface, and even after five or six days, should the patient live so long, the wound will have the appearance of having but recently been made. Death frequently

takes place at the end of three or four days after the beginning of the attack. In these cases the symptoms presented from the very inception of the attack are those of profound septic intoxication and collapse. The pulse is small, compressible, and rapid—120 to 140; the temperature is usually subnormal; the skin is cold and covered with a clammy perspiration; the urine, either suppressed entirely or small in quantity, will contain albumin and casts. Restlessness and delirium give way to coma and death. The abdomen may be retracted, or, because of the absolute intestinal paresis, it may be tympanitic from distention of the intestines with gas.

Recovery from such an attack without operation is inconceivable; and it is in such cases that operative treatment is to be instituted immediately upon the making of the diagnosis. With the source of the infection radically removed and the danger of continuous reinfection eliminated, the prognosis will depend upon the amount and degree of general septic intoxication already present, and upon the reaction of the individual to the methods of treatment instituted to combat it.

Chronic Appendicitis.—An appendix which has been the seat of even so mild a disturbance as an attack of appendicular colic is in an abnormal condition, and is a menace to the health and even to the life of its possessor. When, however, a more serious variety of appendicular disease has occurred, the organ will be left in a distinctly crippled condition, and, as a rule, will be the seat of chronic changes in its shape, its lumen, or in some of its coats. Such an appendix will therefore be more liable than before the first attack to subsequent attacks of the disease. If these attacks are separated by more or less long intervals, during which the patient is free from symptoms, the condition is known as *relapsing* appendicitis; and in this disease the succeeding attacks have a marked tendency to become more and more severe in character. In the *recurrent* variety the intervals between the attacks are short, and the patient is at no time in a state of health; indeed, he is much more commonly a confirmed chronic invalid. The attacks may be mild or severe, with the same tendency as in the relapsing variety to become more and more severe, and are usually accompanied by an increased amount of peri-appendicular adhesions, so that when perforation takes place in these cases the formation of a circumscribed abscess is more apt to occur than general peritoneal infection. The symptoms which accompany the attacks of chronic appendicitis are pain with nausea and vomiting and a varying degree of prostration. Constipation is more common than diarrhea in the chronic form of appendicular disease.

The **prognosis** of appendicitis depends largely upon the variety of the disease under consideration; but the severity of the lesion and of the symptoms is in direct ratio to the virulence of the infection. Another important factor in this connection is the ability of the patient to resist infection. Persons of a gouty or a rheumatic diathesis, those with inactive or diseased kidneys or of well-marked alcoholic habits, or those in whom malnutrition is evidenced by large accumulations of adipose tissue, are peculiarly prone to become victims to infective processes. The condition of the kidneys is perhaps one of the best guides upon which to base a prognosis in appendicitis-septicemia.

When the urine contains large amounts of albumin and many casts it shows that the kidneys are choked with bacteria, and the prognosis is unfavorable with or without operative treatment. That appendicitis frequently occurs and is recovered from sufficiently to permit of the individuals dying of other diseases years afterward, has been amply proved; and it has been recorded that in 230 autopsies, 70 per cent. showed evidences of chronic inflammation in the peritoneum about the ileo-appendicular region (Byron Robinson).

Diagnosis.—An attack of appendicitis accompanied by the characteristic symptoms of the disease is rarely mistaken for any other condition; but other diseases within the abdomen may present many of the symptoms of appendicitis. Inflammations of other portions of the gastro-intestinal tract that are accompanied by pain and vomiting may be mistaken for appendicitis; but they may be early differentiated by the shorter duration of all the symptoms, and more surely by the absence of localized pain and point-tenderness. Inflammation and fecal impaction of the cecum are certainly rare, and need only be mentioned. The passage of gall-stones, with or without distention of the gall-bladder, may be recognized by the history of the case, by the jaundice if present, by the character of the pain and its location, and, if the gall-bladder be distended, by the position of the tumor. In renal colic, when on the right side, the pain and the vomiting with the prostration will often mislead even a very careful observer, and such cases have been operated upon for appendicular disease. The sudden cessation of the pain in ureteral calculus is one of the strong points of a differential diagnosis. A purulent cyst of the ureter has led to operation for a diseased appendix, the symptoms of the case, both subjective and objective, simulating those of appendicitis (Guitéras).

Tumor of the kidney or floating kidney may lead to errors in diagnosis; but a careful history of the case, with a study of the urinary symptoms, will allow of exclusion of the appendix as the cause of the symptoms. To differentiate an attack of typhoid fever from one of appendicitis is at times exceedingly difficult for the first day or two of the illness; but later the range of the temperature characteristic of the former inflammation will make the differentiation easy. The Widal reaction of the typhoid bacillus is of but little positive assistance here, as it is usually present only late in the disease; if present, it might be impossible to know that it was not produced by a former attack, or, if absent, that it would not subsequently develop. The diagnosis between these conditions is rendered still more difficult by the fact that both may be present at the same time, and the perforation that takes place may be from a typhoid ulcer. Again, typhoid fever will often present very irregular symptoms, and occasionally the diagnosis cannot be positively made until the belly is opened. This is especially true where the patient has not been under previous observation, or where no particular symptoms have been noted until perforation has occurred with the sudden development of its symptom. In such a case no satisfactory opinion can be formed until the abdomen is opened and the site of the perforation found. Fortunately, the positions of the perforation in the two diseases are not far apart, and an incision along the outer border of the rectus muscle will give satisfac-

tory access in either case; the perforation may then be surgically treated whatever its cause may have been. The point-tenderness of appendicular involvement is of especial value in this differentiation, and is very unlike the general regional tenderness of typhoid fever.

In children it may be difficult to differentiate an intussusception from an appendicitis with adhesions or with abscess ; but in the former disease the tumor is seldom localized in the right iliac fossa, and the tenderness is general. The history of the case, and especially of its onset, will materially aid the observer in making the diagnosis. Tubercular peritonitis has frequently been operated upon for appendicitis (Morris, Bull) ; indeed, an appendix which has received a traumatism may become infected with tubercle bacilli instead of, or in combination with, the colon bacillus or other pyogenic bacteria, and become the starting-point of a general tubercular peritonitis (di Zerega). Fortunately, opening the abdomen in cases of tubercular infection, with or without removal of the appendix, is the proper treatment, and is frequently followed by happy results; therefore, in a surgical sense, the error of diagnosis is not of great moment. The coexistence of other acute general diseases—scarlet fever (McNaughton), pneumonia (Edebohls), malaria (Simon Flexner), and others—with appendicitis will frequently mask the symptoms of the latter disease or render its recognition slow and uncertain.

Carcinoma of the cecum has been operated upon for appendicitis (Bull), and appendicitis has been found at operation when a diagnosis of cancer of the cecum had been made (J. D. Bryant). Frequently it is even necessary to resort to the microscope for a positive differential diagnosis. The most frequent errors in the diagnosis of appendicitis have, however, been in women, in whom diseases of the appendix and diseases of the right ovary and tube have been mistaken each for the other; indeed, either one existing may be the direct cause of inflammatory disease in the other (Edebohls, H. A. Hare). A most carefully prepared treatise on the differential diagnosis in women has been written by Fowler, who reports a number of cases which show the difficulties encountered.

While appendicitis may be complicated by the simultaneous or consecutive occurrence of any other disease, there is one condition to which especial attention may be drawn—viz., phlebitis. It not infrequently happens that, following an operation for appendicitis, inflammation and thrombosis of the femoral or iliac vein occur; and it is somewhat remarkable that this pathological process is just as frequently found to follow an aseptic operation upon a quiescent appendix as to occur after operation upon a septic case. It is much more common upon the left than upon the right side, which would go to show that it is not of local origin; and yet the patient may present no other signs or symptoms of septic infection. It would seem to be caused by a very mild systemic infection which is not of sufficient intensity to cause general symptoms, but which in that particular individual finds a point of sufficient vulnerability in the wall of the vein for favorable lodgement and the development of infective material.

The Treatment of Appendicitis.—The number of practitioners who regard appendicitis as a medical disease is rapidly diminishing, and

even those who claim that some attacks of appendicitis yield to medical measures are entirely unable to select, in the early stages of the disease, the cases which they have confidence in treating by internal remedies. No medical treatment of proved value for appendicitis has ever been presented to the profession, and the pathology of this disease renders it extremely unlikely that any such treatment will ever be discovered. In other words, every case of appendicitis is liable sooner or later to demand surgical interference for its cure. Nevertheless, the dictum that every case of appendicitis should be operated upon as soon as diagnosis is made is not to be accepted. In many mild cases operation should be delayed until the acute attack has passed, in order that a much better and safer operation may be done in the quiescent period. In some cases the shock and general disturbance accompanying sudden perforations render it advisable to defer operation for at least a few hours; and in others it is wise to postpone operation until favorable conditions, such as light, good assistants, and complete preparations, can be obtained. During this period of delay, treatment which may properly be called palliative should be adopted. Excluding, then, the cases of acute appendicitis which are characterized by such violent symptoms at the very onset that operation cannot be done too soon, palliative treatment is to be made use of on all occasions for a longer or shorter time. Absolute rest in the recumbent position is to be insisted upon; and generally some cold application, such as the icebag or the rubber coil, is of great value in relieving pain and tending, perhaps, to diminish inflammatory action. Counterirritation to the skin over the site of the disease is of no value so far as controlling the disease is concerned, and usually produces an unfavorable effect upon the skin in case operation should be required. As nausea is a frequent early symptom, food and drink, so far as possible, should be omitted. Stimulation, if necessary, may be given by the rectum. In the early stage vomiting is better controlled by hypodermic injections of morphin in small doses than by any other means. Anodynes, however, should be very cautiously made use of until a positive diagnosis has been made, as they tend to mask the symptoms and so to mislead the surgeon. Cathartics should not be employed, as they increase peristalsis and nausea, and, so far as known, have no beneficial effect upon the disease itself. When nausea and vomiting have ceased, fluid nourishment may, of course, be given.

The diagnosis of appendicitis having been established, sufficient anodyne to give reasonable comfort may be made use of; but neither anodynes nor antipyretics should be administered to such an extent as to lead one to underestimate the gravity of the attack. No attack of appendicitis can be considered as recovered from until the function of the bowels has become restored and all other symptoms have disappeared, if we except some slight tenderness when pressure is made over the base of the appendix. This last sign may continue for a long period after all others have disappeared, and even until a recurrence of the disease takes place.

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At the commencement of every case of appendicitis the question of operative interference should be carefully considered, as it is quite possible that a few hours may determine the absolute necessity for opera-

tion; and it is only by the careful study of the signs in each individual case during the first days or hours of its existence, that a safe conclusion can be reached in regard to operative or non-operative treatment. In some cases, within one or two days it will become evident that the attack will soon subside and that a more favorable opportunity for operation may be selected than during the acute stage. In others, again, the study of the symptoms from the beginning may demonstrate clearly that the disease is on the increase, and that the ultimate safety of the patient demands that operation should be done at a very early period. As operation in any case may be very difficult, it should not be undertaken until all the conditions have been made as favorable as possible; and even when operation is indicated by the symptoms, contra-indications, such as coincident disease of a serious nature, may properly induce the surgeon to postpone or even abandon it.

Careful sterilization over a wide area, including the operating-field, should be made, and every precaution should be taken that the work may be done aseptically. Even when pus exists in abundance, as in a large abscess about the appendix, the healing of the wound will be largely influenced by the introduction or the non-introduction of sepsis from without.

Good light, either natural or artificial, is of the utmost importance; and too much stress cannot be laid upon the value of skilled assistants.

Much information in regard to the lesion is frequently gained at the last moment, after anesthesia has become complete and muscular rigidity has entirely passed off. One can often then distinctly recognize the existence of a tumor which before could not be appreciated on account of the rigidity of the abdominal wall or the amount of pain caused by examination. It is well, too, at this stage, if it has not been done before, to make thorough rectal or vaginal examination, as in some cases most valuable information in regard to deep-lying inflammatory masses is obtained in this manner.

In determining the character and size of the abdominal incision, one should be largely influenced by the history of the attack, which will show more or less accurately the probable extent of inflammatory adhesions. As a rule, the presence of an appreciable tumor will determine one to make such incision in the abdominal wall as may be extended, in case of necessity, to permit of wide dissection. In general, incision should be so made that the base of the appendix may readily be reached at an early stage in the operation, although, of course, there are many cases of abscess-formation of greater or less size in which the situation of the incision will be determined by the location of the most prominent part of the tumor. One should never forget in planning the abdominal incision that, so far as is consistent with securing the safety of the patient and the proper treatment of his disease, every effort should be made to avoid the subsequent formation of hernia at the site of operation. Excepting in some very unusual cases, incision of the abdominal wall should always be made to the right of the edge of the rectus muscle and to the inside of the anterior spine of the ilium and Poupart's ligament. No one method of operation is suitable for all cases, for they vary much in the extent of the operative work required and in the difficulties met with. The most perfect oper-

ation can be done in cases of recurring or chronic disease, in which few or no adhesions exist, and in which the methods adopted are almost identical with those that would be made use of in removing a perfectly healthy appendix. It is best, then, to study this nearly normal removal of the appendix first.

In every case of recurring appendicitis surgical interference should be fairly considered during the quiescent period. Many surgeons and most physicians hesitate to urge operation in the case of an individual who has had only one very mild attack, and would advise waiting until other attacks have occurred. In numerous instances the position thus taken will apparently be justified by the outcome, and either no second attack will occur or the second attack will be at least no worse than the first. On the other hand, of a given number of individuals in whom the disease has commenced with a single mild disturbance, a proportion large enough to be of grave importance will at the first recurrence develop a type of the disease that is either very dangerous or even fatal. It is difficult or impossible to predict after one mild attack of appendicitis whether no recurrence, recurrence in a mild form, or recurrence of a severe and dangerous type will ensue. One is forced, therefore, to regard the future of every individual who has had a clearly defined attack of appendicitis—no matter how mild —as uncertain. It is easy enough to reach a conclusion in the case of individuals who have suffered from a number of severe attacks accompanied by much loss of time and disability, and who are suffering from constantly increasing disease. The most frequent difference of opinion among professional advisers will arise in the case of the individual who has had only one attack. My own feeling in regard to such cases is that while recurrence is far from certain, it is extremely probable; and that as the second attack may easily be severe and dangerous, calling for an undesirable form of operation, it is much wiser to select the quiescent period, when all conditions are favorable, to do the safest and best kind of operation. Of course, one must contrast the danger connected with the operation with the danger associated with allowing the disease to recur. That this last danger is a real one there is abundant evidence; and the danger from operation done after one mild attack, and before serious complications in the form of unmanageable adhesions, tumors, etc., have arisen, is so very small (not even 1 per cent. in the hands of some practitioners) that it may practically be left out of consideration. I feel justified, therefore, in advising every patient who has had a single clearly defined attack of appendicitis to have his appendix removed in the quiescent period and before a second attack can occur. Of course, if after the first attack a well-defined tumor or an enlarged and tender appendix can be appreciated, there should be no hesitation in the mind of anyone as to the propriety of early operation. Many lives have been lost through delay under these circumstances. If numerous attacks have occurred, and especially if the attacks have increased in severity, operation affords the only reasonable hope of a restoration to health. The small risk of the operation should be compared with the uncertainty of life, the loss of time, the disability, the impairment of general health, and the constant dread which exists in most cases of recurring

appendicitis; and it is not to be forgotten that if another attack is allowed to occur, a much less successful operation may be demanded to save life at a time when the risk is very much greater.

The bowels should be properly evacuated on the day before operation. A few hours before operation a large enema should be given. The entire abdominal wall should be carefully sterilized.

The particular method of operation—that is, of incision—will depend largely upon the extent of intra-abdominal work that the operator anticipates, and partly upon the experience of the operator. The simplest operation, and the one applicable to all cases, is begun by making an incision in the same line through all the tissues of the abdominal wall. The incision should begin about 1 inch above a line drawn from the anterior spinous process of the ilium to the umbilicus, and should be so placed as to correspond with a line drawn parallel to and about ½ inch to the right of the edge of the rectus muscle. This incision is, of course, not a vertical one, parallel with the median line. The edge of the rectus muscle in the lower fourth is constantly inclining toward the median line. The incision, then, will be quite oblique and nearly in line with the course of the fibers of the external oblique aponeurosis. The external oblique aponeurosis should be exposed and the incision extended through it parallel to the course of its fibers and without cutting them transversely. When the edges of this incision in the external oblique aponeurosis are separated, the tendinous termination of the internal oblique will be exposed. The incision should now be continued through the internal oblique and transversalis muscles, just external to the termination of their muscular fibers in tendon. At this point the abdominal wall is thin, comparatively few muscular fibers are severed, and the edges of the wound are subsequently sutured in layers with great accuracy. This incision avoids the very undesirable opening of the sheath of the rectus muscle. At this stage in the operation the incision through the internal oblique and transversalis should be little more than 1 inch in length, for it is often quite possible through an opening of no greater extent than this easily to extract and remove the appendix. If, after digital examination through the small wound, it is found that larger intra-abdominal section is required—as will surely be the case if an inflammatory tumor exists—the incision can be readily extended upward and downward so as to permit of greatly extended work. Before the peritoneal cavity is opened all blood-vessels should be ligated, all artery-forceps removed, and the wound and the surrounding area thoroughly cleansed and dried. Incision of the fascia transversalis, and peritoneum should be made cautiously, the operator remembering that at any point adhesion of the intestine to the anterior abdominal wall may exist. The finger is now to be introduced through the wound and the appendix searched for. Sometimes it will be readily found, and, if no adhesions exist, can be brought out through the wound, and the rest of the work can be finished outside of the cavity. In other cases very firm adhesions will be discovered, or an inflammatory tumor not previously suspected will be found; in either case it may be desirable so to enlarge the entire abdominal incision as to permit of safe dissection. Frequent search with the finger will not be sufficient; and in order to discover the appendix, it will be necessary to draw out

of the wound the first part of the ascending colon that comes into view, and then, tracing it downward, one will find, when the caput coli is reached, that the anterior of the three longitudinal muscular bands leads directly to the base of the appendix. At this stage it will generally be best, with the aid of the blunt aneurysm-needle, to surround the appendix near its base with a ligature, which should, however, not be tied until later. Even now it may be possible without tearing adhesions to bring the appendix completely through the wound; but frequently the appendix will be found to be very firmly tied down, perhaps forming part of a small inflammatory tumor, and perhaps even communicating with some portion of adjacent intestine by a pathological opening. If the

FIG. 231.—Tying off the mesentery of the appendix.

tip of the appendix can be readily reached and liberated, one may begin the separation of adhesions by tying off the mesentery of the appendix from the tip toward the base. Slight adhesions can generally be broken down by blunt dissection, even with the finger; but if strong and vascular, they should be ligated in sections with fine catgut. If the appendix is adherent to a coil of intestine, much care must be exercised, and in some cases it will be safer to leave a thin layer of the outer coat of the appendix attached to the intestine than to run the risk of injuring the wall of the gut. When the appendix is closely attached to intestine, the point of attachment may cover a communication between the two; and if separation were incautiously made, an opening in the intes-

tinal wall would necessarily be exposed. If this accident happens, the intestinal wound should, of course, be sutured. As a rule, it is best to ligate the mesentery of the appendix in separate sections, the appendix being then cut away from its mesentery beyond the location of the ligatures. Very frequently, however, the distal end of the appendix is deeply and strongly adherent, and even the whole organ may be very firmly bound down by inflammatory products. In such instances one had better begin by detaching the base of the appendix from the colon, the dissection being then made from base to apex. The appendix should usually be severed at a point about $\frac{1}{4}$ inch distant from the colon. It should not be ligated at first between the point of section and the colon, because a stricture or even a complete obliteration may exist between the point of division and the cavity of the intestine. Therefore, before finally disposing of the base of the appendix, one should determine, with the aid of the probe, whether the stump left has free drainage back into the colon or not. If obstacle to free drainage in the form of stricture exists, the stump may be cut off at a still higher point or the stricture may be dissected out from the interior.

In a small number of cases very great difficulty may be experienced in finding the appendix, for by previous inflammation it may have been so altered in shape, size, or position, or be so completely covered by dense inflammatory exudation, as to require most careful search for its discovery. Patient search, however, will always be rewarded; although it may become necessary to enlarge the wound and to displace carefully all overlying pieces of intestine. Even when the eye fails to notice any sign of a deeply buried appendix, the finger may still feel its indurated outline. Careful removal of overlying false membrane and separation of adhesions through natural lines of cleavage will eventually uncover the organ.

If the stump of the appendix has not been previously attended to, it should now be disposed of in one of several different ways: The peritoneal coat of the stump may be brought over the middle and inner coats and carefully sutured with fine silk or catgut; or the mucous membrane of the stump may be cut out and the middle and outer coats sutured; or the stump may be cut away very close to the colon, and that portion of the wall of the colon which includes the orifice be depressed with a probe or forceps, and the edges of the furrow thus made carefully sutured.

Robert Dawbarn has suggested the following excellent method of closing the stump: A continuous purse-string suture of silk, passing through the superficial layers of the cecum $\frac{1}{4}$ inch distant from the base of the appendix, is first placed, but not tied; the appendix is cut away, leaving a stump about $\frac{1}{2}$ inch long. The canal of this stump is dilated with fine forceps, and the stump is then completely invaginated into the intestine. The purse-string suture is to be tied, the instrument used for invagination being withdrawn at the moment of tying. In suitable cases this is a very neat and perfect method; but when the stump is rigid or is much diseased such invagination is impossible; or when the stump is thick and hard and the caliber narrow, the attempt at invagination may result only in depressing the whole stump into the wall of the colon. The remnant of the appendix might under such

conditions entirely fail to drain into the intestine, and abscess in the wall of the colon, with subsequent complications, might ensue.

My own preference in all cases, excepting such as require suture and repair of a considerable opening into the large intestine, is for the following method: The peritoneal coat of the appendix is severed by a circular incision at a point $\frac{1}{4}$ inch distant from the cecum. This coat is peeled back for a short distance toward the intestine, and then complete section of the middle and inner coats of the appendix is made at a point very close to the cecum. The permeability of the stump is first to be determined with a probe, and then with the fine point of the Paquelin cautery the interior of the stump is to be thoroughly burned; with a pair of fine forceps the edges of the stump are brought together, the stump itself slightly depressed, and a purse-string suture of catgut, previously placed $\frac{1}{8}$ inch distant from the base of the appendix, is to be tightly tied. At different stages blood and fluids should have been carefully removed, and occasional washing with hot sterile salt solution resorted to. Every bleeding point should be ligated before the wound is closed, and a final thorough washing with hot sterile salt solution made. The peritoneal wound, also the incision in the fascia transversalis, should be sutured closely with fine catgut. The muscular and tendinous tissues of the abdominal wall are separately sutured and very careful apposition made, in order that subsequent hernia may be avoided so far as possible. If no contra-indication in the nature of the wound exists, its complete closure without drainage is to be preferred. This method, of course, can only be successful when most careful attention has been given to asepsis throughout the entire work. Sometimes, however, one will find in the course of the operation that a small encysted abscess exists as a result of a previous attack. In such cases suitable drainage of one kind or another—usually a strip of gauze is sufficient—is required for safety. Drainage should be discontinued at the earliest safe opportunity, as long continuance of it renders the occurrence of hernia not unlikely. At each end of the skin wound a small strip of gutta-percha tissue will drain the subcutaneous space of serum. This should be removed at the first change of dressings, and never leaves a sinus. The first change of dressings may be conveniently made at the end of forty-eight hours, and any large sutures may be removed at that time. The fine edge-suture had better be left until the sixth or seventh day. If the wound has required gauze drainage from the time of operation, this material should be removed at the first change of dressings, and replaced or not according to the necessities of the case. The recumbent position should be insisted upon for at least three weeks in every case in which the operation just described has been done. Complete repair should then have occurred, and the tendency to hernia will be as slight as possible. No operation, however, which involves a division of the muscular and tendinous fibers of the abdominal wall at right angles to their course is entirely free from the danger of hernia, no matter how small the wound. The reason is that when muscular fibers have been completely cut across, it is totally impossible to replace the tissues forming the edges of the wound so that they will unite with absolute accuracy throughout their entire thickness. The tendency of each

single divided muscular fiber is to retract from the point of division, and every muscular movement increases this tendency. Moreover, such section as has been described necessarily involves the severance of nerves which cross the line of section, and therefore paralyzes the muscular fibers to which they are distributed. The result is that the abdominal wall on the side operated upon cannot have the same muscular strength and capacity for resistance to intra-abdominal pressure as it had before operation. To avoid such damage to the abdominal wall, to allow of absolute replacement of the parts involved, and to do away entirely with the liability to subsequent hernia, the writer devised the following method of operation—one which he invariably adopts
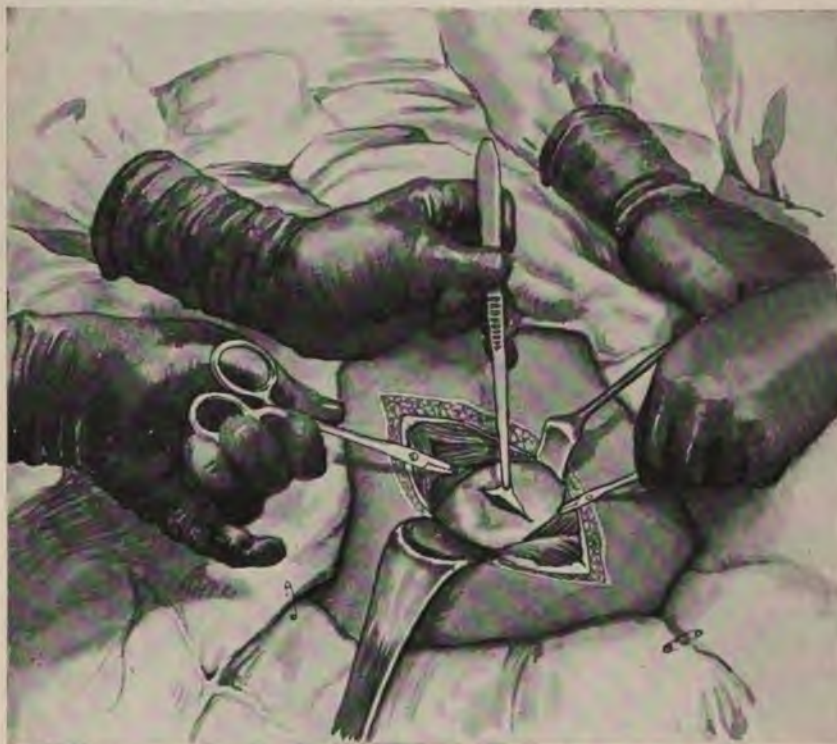
FIG. 232.—Incision and separation of the different layers of the abdominal wall, exposing the peritoneum.

where there are no contra-indications to its use, and which has never, to his knowledge, been followed by the slightest weakness at the site of incision when the wound has been closed primarily without drainage.

Beginning at a point 1 inch above the line drawn from the anterior iliac spinous process to the umbilicus, passing obliquely downward, an incision is made which crosses that line at a point $1\frac{1}{2}$ inches internal to the spinous process, and corresponding as accurately as possible in direction to the fibers of the external oblique muscle and aponeurosis. Separation of the fibers of the external oblique is now made in a line corresponding to the skin-incision, and no tendinous fibers are cut.

Excepting in fat subjects, the incision just described need not be of greater length than 2 or 3 inches. The edges of the wound in the external oblique aponeurosis are to be pulled apart with retractors (Fig. 232), when the surface of the internal oblique muscle will be seen, the fibers of this latter crossing the superficial incision nearly at right angles. At a point opposite the anterior superior spine of the ilium the muscular sheath of the internal oblique is to be divided with scissors in a line parallel with the muscular fiber. With blunt-pointed scissors or the handle of the scalpel the fibers of the internal oblique and transversalis muscles can now be separated, without division, in a line parallel with their course; that is, nearly at right angles to the incision in the external oblique aponeurosis. When the separation is complete the fascia transversalis will be seen lying at the bottom of the wound. Blunt retractors should be introduced through the line of separation, and the edges pulled apart until a considerable area—1 inch or more in diameter—of fascia transversalis can be distinctly seen. If the opening through these two muscles appears too small, it can readily be enlarged by introducing the two forefingers, and by direct traction still further separating the muscles to almost any extent desired. The outer surface of the fascia transversalis, with the peritoneum closely adherent to it, now comes readily into view. With fine-toothed forceps these membranes may be lifted, either separately or together, and an opening made with the scissors. Through this opening one blade of the scissors is introduced and the opening enlarged, first toward the middle line of the body, and then outward toward the anterior spine of the ilium. Excepting from the small vessels of the skin and subcutaneous tissue no bleeding will occur, and no muscular nerves of any size will have been injured. At this stage a suitable sponge or pad on a handle should be introduced into the wound to prevent the escape of intestine or omentum; and while the wound is thus securely plugged at the bottom, its whole superficial area and the surrounding integument should be thoroughly cleansed with hot sterile salt solution and again dried. The sponge having now been removed from the opening in the peritoneum, the edges of the external oblique aponeurosis should be held apart with one set of retractors and the rest of the wound with another pair. Direct inspection of the intestine or omentum which fills the wound can then be made. Some portion of the caput coli or ascending colon is usually to be seen at once, or can be readily found and brought directly into view. If the appendix can be at once felt with the finger and brought out of the wound, the rest of the operation may be finished outside of the abdominal cavity. If it is not so found, the intestine should be drawn out until the base of the appendix is appreciated, and then the operation may be finished as has already been described in connection with the former method. After the appendix has once been identified, it is well to lay aside the retractors, in order that no injury may happen through their use to the intestine. The appendix having been removed and its stump disposed of, the wound in the peritoneum and fascia transversalis is to be closely sutured with fine catgut. Although the fibers of the internal oblique and transversalis muscle fall together as soon as the retractors are withdrawn, it is well to make their apposition complete throughout

the whole depth of the wound with a few fine catgut stitches. The incision in the external oblique aponeurosis is also to be sutured with catgut from end to end. Complete restoration of the elements of the abdominal wall is thus made; and if aseptic healing takes place, absolutely *no* impairment of the strength of the abdominal wall will result. The patient may leave his bed on the thirteenth or fourteenth day.

This operation has the following advantages: Muscular and tendinous fibers are separated but never divided, so that subsequent muscular action does not tend to draw the edges of the wound apart, but rather actively approximates them. Excepting from the skin and subcutaneous tissue no bleeding occurs. The fascia transversalis not being drawn away by the retraction of the deep muscular fibers, it retains its relation to the peritoneum, and with the latter membrane is completely sutured. As muscular fibers and nerves have not been divided, there is scarcely any pain felt. Owing to the absence of nerve-section, it can always be noted in a patient on whom this operation has been done, that there is perfect symmetry of the abdominal wall when the erect posture is resumed; that is, no paralysis of the rectus muscle follows.

This operation requires more time than the simpler one. The opening into the peritoneal cavity can easily be made large enough for any ordinary case, and the opening may be much extended, if necessary, by continuing the separation of the fibers of the internal oblique and transversalis as far as the rectus muscle in one direction, and as far as the anterior spine of the ilium in the other; or if it is desired to make a specially large opening, the separation of the internal oblique and transversalis may be made at a somewhat higher level than the anterior spine, so that the wound may be enlarged outward to a considerably greater extent along the crest of the ilium. If for special reasons a still larger opening is required, it can be obtained by making further section vertically downward from the inner end of the wound, just external to the edge of the rectus muscle. In this manner a considerable triangular flap is made, which can be turned outward and downward, and thus a large area of the abdominal cavity be exposed.

The advantages of the operation are largely dependent upon freedom from deep drainage of the wound, as only in the absence of such drainage can perfect reposition of the separated parts be made. If necessary, however, the deep wound can be drained as in any other abdominal incision.

Operations during the acute stage of appendicitis can sometimes be carried out in a manner very similar to the methods already described; but the fact that the special indication for operating in acute conditions is the evidence that positive infection of the tissues has taken place, demands that such operation should be done as will permit the disease to be eradicated as completely as possible and proper drainage to be made. Whether the infection is still confined to the appendix alone or has already reached the tissues surrounding it, safe treatment requires that the whole involved area should be exposed, disinfected with great thoroughness, and carefully and efficiently drained. Such symptoms as indicate at the end of twenty-four or thirty-six hours that the disease is progressing, and that there is positive danger in allowing it to progress further, call for immediate operation in the acute

condition. These symptoms may be high temperature, quick pulse, intense pain, and clearly defined muscular rigidity; and yet in many cases equally severe, one or more of these symptoms may be absent. The important indication is a progressive infection; and if one is in doubt as to the necessity for operation, it is far wiser, when no special contra-indication exists, to operate than to delay. In some cases it is perfectly evident within the first few hours that operation should be done immediately, for the severity and rapid increase of the symptoms clearly indicate the serious illness of the patient. When pulse and temperature are both high, when vomiting is persistent, and when the signs of a rapid involvement of peritoneum are present, operation should be done at once. In other cases, although both the pulse and temperature may be low, the general appearance of the patient will indicate dangerous sepsis. An abnormally sallow color, a general sense of weakness, a feeble pulse, ill-defined pain in the usual locality, with rather widespread tenderness on pressure, especially over the pelvis, are indications of a septic condition of dangerous importance. With such signs gangrene of the appendix often exists, or a suppurative condition without limiting adhesions.

It is very evident that it is not necessary to operate immediately upon every case of acute appendicitis, for we meet with numerous patients whose histories show clearly that they have had a number of acute attacks and have apparently recovered from each one of them. Nevertheless, every acute attack is worthy of careful study and frequent observation, for only by such attention can we distinguish between the cases which should be operated upon at once and those in which it will be wiser to allow the attack to subside, in order that better and safer operation may be done during the period of quiescence. It is very much to be hoped that no practitioner will so construe the last statement that he will be encouraged to delay attending to important cases in the mere hope that their attacks will subside. Careful watch at least should be maintained, so that the slightest change for the worse may be appreciated.

The usual type of acute appendicitis is characterized by sharply defined signs such as have been already described. These cases should be frequently observed during the first twenty-four or thirty-six hours. In some of them it will become very clear long before this period has elapsed that operation should be done immediately; and in many others, although by the end of twenty-four or thirty-six hours the symptoms are becoming only moderately more severe, operation should be done. Operation at this stage is not difficult; it is radical and very safe. It is true that if no operation be done, the patient *may* recover from this particular attack; with strong probability, however, that the disease will recur, or an abscess will form which will require operation at a less favorable time, or that general septic peritonitis will be initiated, from which, even with operation, most patients die. If at the end of the same period the condition of the patient is doubtful and it is uncertain whether the attack is subsiding or getting worse, the safer course is to operate. It is a grave mistake to delay until highly developed signs of serious disease have arisen before deciding to interfere. To be at all uniformly successful,

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operation must be done before the gravest signs of disease have appeared. If at an early period it becomes clear that the attack is a mild one and will readily subside, operation should be postponed until all signs of illness have disappeared. The wisest course will then be to operate upon such a patient during the quiescent period and before he can suffer from another attack; but such operation should not be done immediately after the subsidence of the acute attack, as some little time is required to get rid of infection in and about the appendix. So long as any active infection exists, the operative wound cannot safely be treated without drainage, and the most perfect result, as regards the strength of the abdominal wall and freedom from liability to hernia, can only be obtained when the wound is completely closed. In most cases this favorable time will have been reached about ten days after subsidence of the acute attack.

In acute cases the abdominal incision should be so placed that the appendix may be readily removed, the surrounding tissues thoroughly cleansed, and the whole area properly treated with completeness and safety. Careful examination after the patient is thoroughly anesthetized should be made to discover, if possible, the exact situation of the appendix or of the suppurative process about it, which is generally indicated by the presence of tumor. The result of this examination may lead one to carry the incision further upward or downward than usual, or to place it along a line very near to the outer part of Poupart's ligament. Frequently in acute cases an oblique incision quite close to the anterior spinous process of the ilium and Poupart's ligament is to be preferred to the incision made near to the edge of the rectus muscle. Through such incision septic material can be most safely removed and drainage most perfectly maintained. Moreover, there is less liability to hernia when the wound lies near the edge of the abdominal cavity than when it is nearer the median line.

As regards operation, most acute cases may be placed under one of two heads: First come those in which it is evident before operation is begun that the general peritoneal cavity must be deliberately opened as soon as the abdominal incision has been made. Secondly, those in which the abscess approaches and involves the anterior abdominal wall, so that the abscess may be opened without invading the non-infected part of the general cavity. The large majority of acute cases that are operated upon within the first two or three days of the disease belong to the first class; and in the second class we find many of the abscess cases of longer standing and which are operated upon at some period after the third day.

When operating upon one of the first class of cases the operator should begin with the full intention of searching for the base of the appendix as soon as the peritoneal cavity is opened, for if the base of the appendix is identified, the remainder of the operation can usually be completed with certainty and safety. Of course, not infrequently some other portion of the appendix than its base will be immediately appreciated, in which case the separation of the appendix may commence with the part first discovered. One should begin his incision at a point about 1 inch above the anterior spinous process of the ilium and $1\frac{1}{2}$ inches internal to that process, and the skin should be

incised obliquely downward for about 4 inches in a direction parallel with that of the fibers of the external oblique aponeurosis. The fibers of this aponeurosis should be separated in a single line, without other injury, throughout the whole length of the incision, and the edges of this wound should be held apart with retractors. At this point one may recognize acute edema of the connective tissue, indicating that the inflammatory process lies just beneath or near to the anterior wall of the abdomen. The internal oblique and transversalis muscles are now to be cut in the same direction, nearly at right angles to the course of their fibers. This muscular incision should be some 3 inches in length, so as to allow of free access to the lesion. Immediately beneath the deepest muscular fibers will be found the transversalis fascia, often thickened by edema so as to resemble a dense new-formed tissue. This fascia should be divided without cutting the peritoneum. All bleeding vessels are to be ligated, and all clamps and retractors laid aside. The whole wound and the abdominal wall are to be thoroughly cleansed, and then the peritoneum should for the first time be opened. The incision in the peritoneum should correspond in length with that in the fascia transversalis, in order that, from the beginning of the inspection within, complete control of the diseased area may be maintained. At this stage not infrequently fluid, either of a pure serous character or more or less turbid from septic changes, will be seen. All such fluid should be removed with sponges before any other step is taken. The situation of the appendix can now usually be determined by the finger, for in acute cases it will be markedly enlarged from inflammatory swelling, and even closely wrapped in an overlying mass of omentum. Free intestinal coils which tend to bulge into the wound are to be pushed to one side or upward and downward, and held in this position by the operator's assistant, aided by sponges or gauze. Generally in this manner complete ocular inspection of the inflammatory mass can be made. Fresh adhesions should be gently separated with the finger until the appendix is entirely uncovered or it is evident that an abscess-cavity is close at hand. Before such cavity is opened renewed precautions are to be taken, lest with the escape of pus some portion of the non-infected general cavity should receive the fluid. With care such a space around the lesion itself can be so safely walled off that the fluid may be evacuated and safely removed. If pus exists, it should be entirely removed before any other step is taken. The cavity which held it should also be gently but thoroughly cleansed, and for this purpose nothing is better than careful irrigation with hot sterile salt solution. The appendix may now be entirely separated from the tissues to which it is adherent, the mesentery ligated in sections with catgut, and the appendix cut free until it remains attached to the colon by its base only. If the base of the appendix is healthy, as it often is, the appendix should be divided about $\frac{1}{4}$ inch from the cecum and without previous application of ligature. The canal of the stump should now be probed to ascertain whether or not it opens freely into the intestine. If it does, it should be tied with catgut quite close to the intestinal wall, its interior having previously been disinfected with the fine point of the Paquelin cautery; or, after the ligature has been applied, the interior of the stump down to the

ligature may be cauterized with pure carbolic acid. When the stump is thick and hard, or partially gangrenous or entirely necrosed, it may be necessary to handle it in a different manner and somewhat imperfectly. Certainly all necrotic tissue should be removed; and if in doing so a distinct opening into the large intestine is left, this must be carefully inverted and stitched. In some cases the appendix will be found so closely identified with the wall of the abscess, that its removal would involve no little risk of infecting the tissues behind it; or when suppuration is abundant the operator may have been entirely unable to discover the appendix. In either case it must depend upon the judgment of the operator whether it is best to insist on the removal of the appendix, no matter how difficult and prolonged the dissection, or to leave it and trust that the reparative wound-healing will render it harmless. Certainly in some cases it is much wiser and safer to leave the appendix than to insist on a dangerous and prolonged dissection. It is true that occasionally a remnant of appendix which has been deliberately left will at a later period be the cause of a fresh attack of appendicitis; or it may considerably prolong the healing of the wound. Nevertheless, the most important consideration for the time being is the life of the patient; and it is much better to remove the appendix by a second operation done at a favorable time, than seriously to risk the patient's survival at the first operation.

The wound should now be thoroughly cleansed throughout its entire extent by gently washing with hot salt solution. Irrigations with such fluids as bichlorid and carbolic-acid preparations have no better cleansing effect, and leave the tissues in a condition unfavorable for healing. The wound having been cleansed and the sponges or pads removed, the intestines should be carefully held out of the way by the fingers of an assistant, and iodoform gauze introduced so that it may lie in contact with every portion of tissue that has been infected. Such gauze drainage is always to be preferred to that of tubes. In many cases the abdominal wall may be partly sutured. In some instances, where the entrance to the abscess-cavity is necessarily very small and the depth and extent of the cavity great, so that gauze cannot be properly introduced, a well-placed tube may be valuable. Each operator must decide for himself in each case how much of the wound may be closed by suture; but he should never forget that the life of the patient who has been operated upon for acute appendicitis at a time when there is always more or less infection of the surrounding peritoneum, is safer if the wound is left entirely open and thorough gauze drainage is made use of, than it is when drainage is limited and the wound largely closed. The outer dressing should be large and thick, and is best made of sterilized gauze. Over this dressing a broad, firm bandage should be applied. Immediately after operation the patient should receive a hypodermic injection containing $\frac{1}{8}$ grain of morphin and $\frac{1}{200}$ grain of atropin. A stimulating enema may be given or not according to the necessities of the case; but certainly nothing should be given by the mouth for a good many hours unless it be a small quantity of hot water to diminish thirst. By the end of twelve hours most patients will be able to take fluid nourishment, which may be given to them in increasing amount during the

first two or three days. Solid food may then be given in moderation if the symptoms permit. During the first day or two after operation accumulations of gas in the intestinal canal, which the patient is unable to expel, frequently give rise to a good deal of pain. This condition can generally be relieved by a hot-water enema, or the rectal tube carefully introduced will answer the same purpose. The ability to expel gas generally returns by the end of the second day. The outer dressings should be changed on the day following operation, as they will often be found quite wet from serous drainage. The deep-wound packings should be removed on the third day unless they are found to be so adherent that they cannot be safely drawn out, in which case it is often better to allow them to remain another twenty-four hours. When the deep packing is removed the wound should be held open with the flat retractor, gently cleansed with pledgets of cotton wet with sterile salt solution, and then should be again packed, but with much less gauze than was introduced at the first dressing. The wound-dressing should be repeated every second or third day, the packing being made less on each occasion as the wound closes from the bottom. When reduced to a shallow granulating cavity, this may be gently curetted and the skin wound tightly sutured.

The method just described is that which should be made use of in the management of the average case where the infection is confined to the usual situation of the appendix and its immediate neighborhood; but often marked variations in the details of the method must be made in order to meet the peculiarities of the case. The appendix may pass in an upward direction, along the outer side of the colon, as far as the kidney or liver, so that its dissection may require a considerable prolongation of the incision upward; or it may extend downward into the pelvis, or even across the peritoneal cavity to the left side. In none of these conditions, however, is it necessary to essentially alter the situation of the abdominal incision.

In the second class of cases, when a well-defined abscess lies near to and involves the anterior wall of the abdomen, its cavity may be reached without handling the non-infected peritoneum. In these instances the tumor is usually a week or more old, and, as a rule, its most prominent portion will be found lying next to the outer half of Poupart's ligament. In some instances this most prominent portion occupies a situation nearer the median line or well up above the crest of the ilium. It can generally be easily recognized by palpation; but the percussion over it is not always dull, as gas, produced by decomposition, may give rise to tympanitic resonance. In general, one should approach such abscesses as near the outer edge of the peritoneal cavity as is possible, although their situation may require incision at a quite different point. Usually, however, incision will be made close to and parallel with the outer half of Poupart's ligament. Palpation will generally determine, before the incision in the abdominal wall has been completed, at what point the abscess can be entered without opening the general peritoneal cavity. The deeper tissues will be found edematous and thickened; and the more clearly these changes are defined, the more certain is it that the pus is close at hand. If inflammatory changes in the abdominal wall, as one approaches the peritoneum, are

entirely absent, one may feel quite sure that the abscess lies more deeply than was expected, and that the general peritoneal cavity will be necessarily opened before pus can be evacuated. This condition is not accompanied by any special danger, for careful attention to the exclusion of the general cavity, by means of sponges or gauze pads, before pus is allowed to escape, will provide against all risk. Wherever it may lie, the actual opening of the abscess-cavity should be made with great caution, so that fluids may escape extremely slowly, and thus render it possible to remove them gradually and before any general wetting of the surrounding tissues can take place. One should rarely attempt to make the final opening of the abscess with the point of the knife unless it is perfectly clear that fluid lies immediately beneath. Generally it is safer to separate adhesions or break through the overlying peritoneum with the end of the finger or with some blunt instrument. This precaution will prevent one from accidentally cutting into an adherent portion of intestine. When the fluid has partly escaped the opening may be enlarged. The cavity can then be completely cleansed by the gentle use of small sponges; and finally the entrance to the abscess should be extended upward and downward as far as may be safely done, in order that subsequent treatment may be rendered more thorough. One should search carefully with the finger for loose fecal concretions and for the appendix itself. This latter may have already escaped in the form of a slough, or it may still remain and hang loosely in the pus-sac. The greatest care should be taken not to break the wall of the abscess at an unprotected point, lest general infection of the peritoneum result. If the appendix can be readily found and removed, it should certainly be taken away and the stump treated in the usual manner. As a rule, in abscess cases it is quite sufficient to cauterize and ligate the stump of the appendix without any attempt being made to suture it. Even if no suture can be applied, the stump will almost invariably heal after cauterization if gauze packing is introduced and laid directly against it. As already explained, no very prolonged search for the appendix in abscess cases, and no dangerous dissection for its removal, should be made.

The appendix is frequently completely destroyed by the suppurating process. Prolonged search for it in such cases would, of course, be purely harmful. If it has not been destroyed, it is frequently obliterated by the subsequent process of repair. Not infrequently have patients been sacrificed to excessive zeal in handling the cavity of these abscesses, and this is especially true of children. The only *very* important point is to give free exit to the pus; and after this has been done, the less the operation is prolonged the better.

When, as is sometimes the case, a very old abscess has approached so closely to the rectum or vagina or the loin that the tissues over it are extremely thin, scarcely anything more is needed than incision at the most prominent point. In some of these cases, however, owing to the extent of the suppurating process, it may be necessary to make a second incision to provide for satisfactory after-treatment.

Some most important cases not included in the two classes just described are characterized by entire absence of any natural attempt to localize the process through the formation of a protecting wall of

adhesions or by incompleteness of this protecting wall. In these, infection of the peritoneum spreads rapidly from point to point, this infection being accompanied by abundant production of septic fluid, which first fills the pelvis and then overflows and involves the whole cavity. If seen at a late stage in the process, the symptoms of this condition are usually clearly defined, the most characteristic one being a tenderness to pressure over a very wide area. In many instances of this class, however, at an early stage it is quite impossible, before incision has been made, to decide whether the septic process is a local or a general one; but the moment the peritoneal cavity is opened, the escape of more or less turbid serum and the appearance of actively inflamed intestinal coils make the character of the case clear. In such cases, as soon as the peritoneum has been incised, fluid should be removed with the sponge as fast as it appears. When the immediate area beneath the incision has been cleared, further search for fluid should be made, and generally the larger quantity of septic material will be found in the pelvis. If it is even suspected that this cavity is involved, the whole of it should be carefully examined and every particle of septic material removed. After this has been done—and search should also be made in other directions for seropurulent accumulations—the appendix itself should be sought for and removed. Then systematic washing of every portion of the peritoneal cavity that has been involved should be made. For this purpose no fluid is to be compared to the hot sterile salt solution of the strength of $\frac{6}{10}$ of 1 per cent. Such a solution has no damaging effect upon the endothelium of the peritoneum, for with it one may cleanse without injuring the most delicate tissue. The temperature of the solution should be not lower than 115° F., nor higher than 120° F. The temperature can be quite accurately estimated with the hand: if one can bear to hold the hand continually immersed in the solution, it is not too hot. While the wound is held wide open by the fingers of an assistant, this fluid should be freely poured in from a pitcher. This first washing will cleanse the immediate neighborhood of the wound and of the appendix. The intestines should then be still further held to one side, so that the solution may pass deeper into the cavity. This again should be removed with sponges, and then the washing introduced to a deeper point still. Finally the pelvis should be completely filled, a sponge on a long handle thrust down to the deepest point, and while the fluid is still being poured in, the sponge should be drawn up and down very much like the piston of a pump. Sooner or later the fluid will return perfectly clear, and then the operator's attention should be given to any other infected area that may exist; and if the process is extremely widespread, involving the whole cavity, the intestines should be completely drawn out of the wound, in order that the cleansing process may be made absolutely complete. Of course, all of this work should be done as rapidly as is consistent with thoroughness, for the condition of patients suffering from general septic peritonitis of the character described is always unsuited to prolonged anesthesia and manipulation. Complete removal of septic material offers the only hope of success. After this process an abundant serous discharge from the peritoneal surface is sure to take place; therefore drainage should be very thorough. A large glass drainage-

tube, open at both ends and with small lateral openings, long enough to reach from the abdominal wound to the bottom of the pelvis, should be passed in near the lower angle of the wound. Some fluid will immediately be found at the bottom of the tube. This should be removed with the aid of a strip of gauze until the tube is found to be quite dry. Sometimes a similarly infected area will be found to the right of the colon, involving the anterior surface of the kidney and the lower surface of the liver. When this is the case, a glass tube should be passed from the upper angle of the wound to the highest point that requires drainage. The rest of the wound should be extensively drained by means of iodoform-gauze packings, strips of which, in extensive lesions, should be introduced in various directions among the folds of intestine. Finally the whole neighborhood of the appendix, the wound being left wide open, is to be well filled with gauze. All patients who have been subjected to the treatment just described should receive after operation a stimulating enema containing an ounce of whiskey or brandy, and a hypodermic injection of morphin. If shock is well marked, they should also receive an intravenous infusion of hot sterile salt solution, which is best introduced through a vein at the bend of the elbow. Before the outer dressing is applied, strips of gauze should be passed to the very bottom of the glass tubes and allowed to remain. These should be removed at the end of from four to six hours, and dry strips inserted. This process should be repeated from three to four times in the course of the first day; and if by the end of thirty-six hours the tube is found to be dry or to contain but a small quantity of perfectly clear serum, the glass tube may be permanently removed, a single narrow strip of gauze being left in its place. The outer dressings are to be changed whenever they become wet, the deeper packings at the end of three days; although in some cases the difficulty of removal may be so great that it will be necessary to leave them in place one or two days longer. These, of course, should be replaced by fresh packings much less in size. At the beginning of the second day, or soon after that period, $\frac{1}{2}$-grain doses of calomel should be given once an hour for from six to eight hours; this medication to be followed within an hour or two by a large, hot enema. If no evacuation of the bowels and no passage of wind occur in consequence of the medication and enema, saline cathartics should be administered until an evacuation is obtained. Complete change of the dressing should now be made every second or third day, the quantity of packing being made less on each occasion. As a rule, in the treatment of these open wounds left after operation for suppurative appendicitis, irrigations and other medicated applications should seldom be used.

If the operation has been well done and the infected area thoroughly cleansed, little or no discharge will be met with when the first change of dressings is made. Gentle cleansing of the wound with pledgets of sterile cotton or sterilized gauze is in most cases all that is required before the wound is repacked. If, however, a somewhat abundant purulent discharge continues, it will be well to wash this away with a hydrogen-peroxid solution or with normal salt solution. As soon as the wound becomes perfectly clean even iodoform gauze should be

avoided, the packings being made of plain sterilized material. In successful cases it will be very clear by the end of two days that all danger is past, for the temperature will become nearly normal, nausea will not return, and all the signs of rapid convalescence will be recognized. Sometimes, however, after a few days of apparent normal condition the temperature and pulse will again rise and pain and nausea return. These indications of relapse are very sure to be due to a secondary formation of abscess which has originated from some remnant of the primary septic exudation that had been overlooked among the intestines. Such a collection is certain to give rise to constitutional disturbance, and to increase in quantity until it evacuates itself spontaneously or with the assistance of the surgeon. If it lies in the immediate neighborhood of the wound, such evacuation is likely to take place at that point; but if its situation is at some distance from the abdominal wound, it may require fresh incision for its relief. The exact position of such secondary collections can usually be determined by localized tenderness on pressure. If the operation in cases of septic peritonitis has been imperfectly done, or if the general sepsis had already become too intense to be relieved by washings and drainage, the original symptoms will not entirely subside, and will after a few hours return with renewed vigor. High temperature, vomiting, a rapid, feeble pulse, and increasing distention of the abdomen will be noted. In this event death will be inevitable, and in such cases it is useless to attempt a secondary cleansing.

When the wound has been imperfectly disinfected at the time of operation, or when the disease has affected especially the base of the appendix and the adjacent portion of colon, complete closure of the entrance to the colon may not occur. In such cases, at the second or third dressing some fecal discharge will be noted in the wound, and this, of course, indicates the existence of fecal fistula. As a rule, no immediate treatment for such fistulæ is advisable, it being only necessary to cleanse and pack the wound more frequently than in an ordinary case. Most of these fecal fistulæ gradually close without other help than cleanliness and packing. It is useless to apply sutures to such fistulous openings while the wound is actively discharging. If applied at this stage, such sutures are certain to cut their way out. Generally, as the whole wound contracts in size, the fecal fistulæ will not infrequently heal without the surgeon's help. It will be quite soon enough to discuss the question of special operation for the closure of such fecal fistulæ after the general wound has healed at all points. When nothing remains but a small fistulous orifice, a few applications of the Paquelin cautery will frequently serve to complete the closure. If such fecal fistulæ or other chronic opening persist unchanged, showing no tendency to diminish in size, the question of radical operation should be discussed. It is generally very unsafe to attack such openings directly with the knife, for the danger of opening some adjacent coil of intestine is very great. If radical operation is determined upon, it is better to make a fresh laparotomy near the original wound, and so guard against the injury of intestines. Through this new opening the necessary work can be safely done. The old fistula, or the remnant of the appendix, or the margin of a fecal opening, can now be deliber-

ately dissected out, and careful suturing of any unnatural opening into the gut be made. The edges of the fecal fistula should be completely refreshed with the scissors, and the opening closed by inversion of its margins and careful suturing. Occasionally, to secure recovery from large chronic openings into the colon, it will be necessary to resect a portion of the intestine, and follow this operation with an immediate anastomosis. All these abdominal wounds which it has been necessary to treat wide open or by extensive packings are likely, within a brief period after complete healing has occurred, to yield at the scar to intra-abdominal pressure until a more or less well-defined hernia has been formed. It is well to provide in all of these cases against the occurrence of such defect, and these patients should be urged to wear a well-fitting elastic band as soon as they resume the erect position. Some patients require for the proper treatment of their cases to wear a band that is provided with a convex pad placed directly over the cicatrix. Generally, however, such pads should be omitted, sufficient support being given by a broad band.

CHAPTER XIV.

SURGERY OF THE LIVER, GALL-BLADDER, BILIARY PASSAGES, AND PANCREAS.

Anatomical.—These organs, all situated in the upper abdomen, are connected by peritoneal folds which in certain cases contain their blood-supply; hence a clear understanding of the peritoneal relations is important to the surgeon.

Fig. 233 shows the peritoneal folds and ligaments which are visible when the abdomen is first opened.
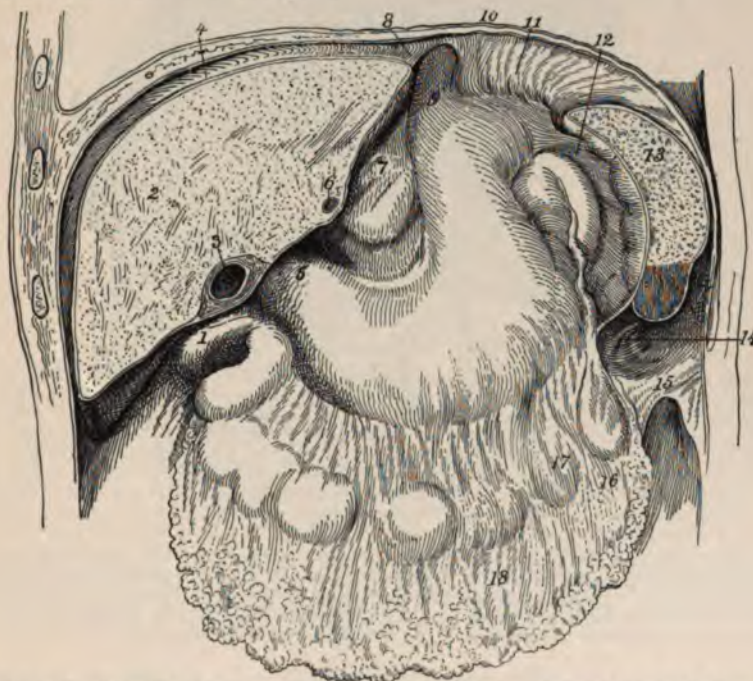
FIG. 233.—Hepatic and splenic ligaments (after Henle): 1, hepatic flexure of the colon; 2, liver; 3, gall-bladder; 4, ligamentum coronarium hepatis; 5, pylorus; 6, ligamentum teres; 7, lobe of Spigelius, showing in outline through the gastrohepatic omentum; 8, ligamentum triangulare sinistrum; 9, upper end of stomach; 10, diaphragm; 11, ligamentum phrenico-gastricum; 12, ligamentum gastrolineale; 13, spleen; 14, splenic flexure of colon; 15, ligamentum phrenicocolicum; 16, transverse colon; 17, ligamentum gastrocolicum; 18, gastrocolic omentum.

In Fig. 234 the lesser omental cavity has been opened by cutting the peritoneum between the stomach and colon. The stomach is drawn upward and the colon downward, showing the interior of the lesser omental cavity, with the pancreas and a part of the spleen appearing

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just under the peritoneum. A probe is passed through the foramen of Winslow and comes directly into the lesser omental sac.   This illustration suggests plainly that inflammations and diseases of the pancreas would extend almost at once to the lesser omental cavity, which is a closed sac; also, that the most direct route to the pancreas is through the gastrocolic ligament between the stomach and the transverse colon.

In Fig. 235 the liver is held up to show the gastrohepatic omentum.

M. H. Richardson in 1893, and Morrison again in 1894, demonstrated the fact that there exists a pouch, below and behind the liver, which is more or less isolated from the peritoneal cavity.   Richardson

FIG. 234.—Interior of the lesser omental cavity (after Henle): 1, right lobe of liver; 2, gall-bladder; 3, posterior wall of stomach; 4, posterior blade of gastrohepatic omentum; 5, lobus Spigelii; 6, pancreas; 7, spleen; 8, the part of the spleen covered by the lining of the lesser omental cavity; 9, vena linealis; 10, transverse colon; 11, great omentum; 12, anterior upper blade of the mesocolon; 13, first flexure of the duodenum.

thus describes it: "The right upper quadrant of the abdomen, containing the liver, gall-bladder, and portions of the kidney, stomach, and duodenum, is separated from the peritoneal cavity below by the transverse and ascending colon with their mesentery.   The colon is usually in contact with the abdominal wall from the ileocecal valve to the splenic flexure.   Extravasations will be immediately opposed by this intestinal and mesenteric barrier, which may, however, be avoided by travelling downward along the right border of the ascending colon. In extensive extravasations the fluid will easily overcome any such obstacle, but in the slow escape of bile the opposing surface will be

sufficient to prevent, by rapid adhesion-formation, any considerable infection." This space can often be drained with advantage by an opening posteriorly just below the kidney.

The **liver** is situated in the right hypochondriac region, and extends across the epigastrium to about 1½ or 2 inches beyond the left margin of the sternum. Its upper surface is moulded to fit the arch of the diaphragm. It is protected on the right side by the ribs, but in the middle line it lies just beneath the abdominal wall in front of the stomach, and extends down to a point about half-way between the xiphoid car-
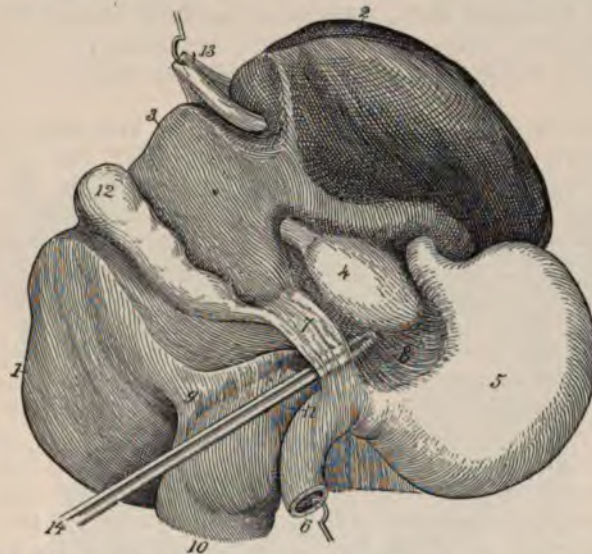
FIG. 235.—Peritoneal folds connecting the kidney, duodenum, and stomach to the liver (Testut): 1, right lobe of liver; 2, left lobe; 3, quadrate lobe; 4, lobus Spigelii, showing in outline through the semi-transparent gastrohepatic omentum; 5, stomach dragged downward; 6, duodenum; 7, pars hepatoduodenale; its right border bounds the foramen of Winslow. This part of the gastrohepatic ligament is of great importance to the surgeon, because it leads him to the foramen of Winslow, and with a finger in the foramen and the thumb on this peritoneal fold, he holds the bile-duct and the hepatic vessels and nerves between his fingers. A vertical incision through this fold exposes the common duct, the head of the pancreas, and the under surface of the duodenum where the common duct and the pancreatic enter it. 8 and 4, pars flaccida, the transparent lax portion of the gastrohepatic omentum. On cutting this fold of peritoneum the lesser omental cavity is opened; the surgeon can therefore approach the pancreas either above or below the stomach, as in Fig. 234. 9, ligamentum hepatorenale; 10, right kidney; 11, right adrenal; 12, gall-bladder; 13, umbilical vein; 14, sound passing through the foramen of Winslow and ending in the lesser omental cavity.

tilage and the navel. The right lung lies in front of the liver as far down as the sixth rib in the nipple-line, and the heart as far as the same rib on the left side. Behind, the right lung is over the liver as far down as the eleventh dorsal vertebra.

The liver is quite movable, and its position varies with inspiration and expiration, as well as with changes in the position of the body. The relative position of the lung may be greatly altered by disease of either the lung or the liver. Its position varies also with the ascent or descent of the diaphragm.

The *gall-bladder* is situated in the fossa on the under surface of the

right lobe of the liver, to which it is usually attached by areolar tissue. In case of ordinary distention, it is in contact with the abdominal wall at a point opposite the tip of the cartilage of the tenth rib. It is not possible to feel a normal gall-bladder through the abdominal wall. It is in contact with the liver and abdominal wall above; with the liver, and often the pylorus, and the hepatic flexure of the colon below. It is therefore possible to unite the gall-bladder with either the duodenum or the colon.

The peritoneum completely invests the fundus of the gall-bladder, but covers the body and neck only on the under surface. When the peritoneum is cut and the areolar tissue between the gall-bladder and liver dissected, it is held only by a pedicle consisting of the cystic duct and its artery and veins, and can be easily cut away if the pedicle is tied.

The *cystic duct* is about $1\frac{1}{2}$ inches in length, and passes backward and downward and to the left from the neck of the gall-bladder, and joins the hepatic duct to form the common duct. At its point of junction it lies in front of the lower surface of the portal vein. The cystic artery is on the left side. Its mucous membrane is raised into a series of folds which project into the duct, giving the appearance of a spiral valve. Gall-stones are frequently caught in these folds and obstruct the duct. The normal duct is very small and cannot be catheterized; but the enlarged duct will often admit a finger.

The *hepatic duct* is formed by the union of a right and a left branch which come from the bottom of the transverse fissure of the liver. It descends to the right, within the gastrohepatic omentum, in front of the portal vein, and with the hepatic artery to its left. It is about 2 inches in length, and joins the cystic duct to form the common.

The *common duct* is situated at the right free border of the hepaticoduodenal ligament or at the free border which forms the fold at the entrance of the foramen of Winslow. The hepatic artery is situated on its left side close to it, and behind both lies the vena porta (Henle). It passes behind the first part of the duodenum and then between the pancreas and the descending portion; joining the pancreatic duct, it passes obliquely through the inner wall of the descending portion of the duodenum. Fenger describes a case where the portal vein overlapped the right, or lower, border of the common duct in its upper half, making it unsafe to incise the duct at that point. The relation of the gall-ducts to the portal vein and hepatic artery is so intimate that the ducts should always be cleared before they are incised. The obstructed and enlarged ducts may show a wide variation from the normal, but they are usually not difficult to trace.

The **pancreas** is a long gland lying across the posterior wall of the abdomen behind the stomach, opposite the first and second lumbar vertebræ (Fig. 236). The head of the pancreas is embraced by the second, third, and fourth parts of the duodenum. The superior mesenteric vessels are in contact with the anterior surface near the left border.

The superior and inferior pancreaticoduodenal vessels pass down in front of the head and near the right and left borders. Posteriorly it lies upon the inferior vena cava, the left renal vein, and the aorta. The com-

mon bile-duct lies behind it. The tail extends to the left as far as the spleen and is placed over the left kidney. The duct runs through the entire length of the gland from left to right; near its termination it runs side by side with the common bile-duct into the muscular coat of the duodenum, and finally opens by a common orifice into the intestine.

The pancreas lies behind the posterior wall of the lesser omental cavity and between the blades of the mesocolon of the transverse colon. It may be exposed in three ways: (1) by cutting the peritoneum between the greater curvature of the stomach and the transverse colon (Fig. 234); (2) by dividing the inferior layer of the mesocolon; (3) by tearing through the gastrohepatic omentum (Fig. 235).
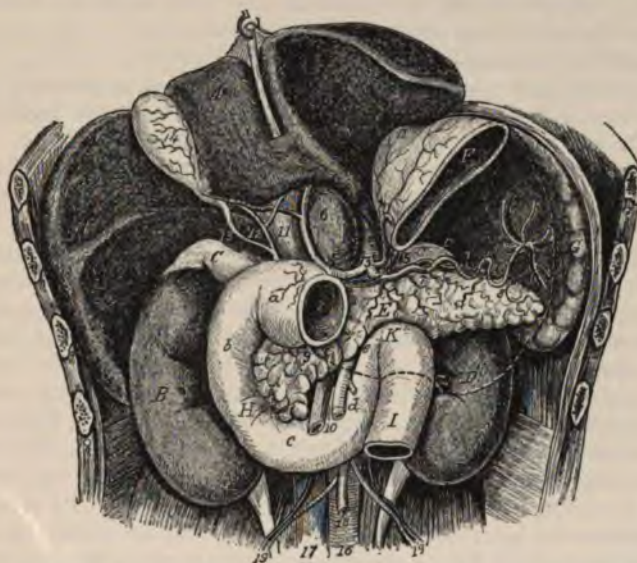
FIG. 236.—View of duodenum and pancreas. The part of stomach removed is indicated by dotted lines (Testut): *A*, quadrate lobe; *B*, right kidney; *CC'*, right and left suprarenal capsules; *D*, left kidney; *E*, pancreas; *F*, upper part of stomach; *G*, spleen; *H*, duodenum, with *a, b, c, d, e*, its five parts; *I*, jejunum; *K*, duodenojejunal angle. 1, lower end of esophagus; 2, pyloric orifice; 3, celiac axis; 4, coronary artery; 5, hepatic artery; 6, Spigelian lobe of liver; 7, 7', splenic vessels; 8, left gastro-epiploic artery; 9, right gastro-epiploic artery; 10, superior mesenteric vessels; 11, portal vein; 12, hepatic duct; 13, cystic duct; 14, gall-bladder; 15, left crus of diaphragm; 16, aorta; 17, vena cava inferior; 18, inferior mesenteric vessels; 19, spermatic vessels.

Krönlein caused gangrene of the transverse colon by tying the colica media artery close to the lower border of a sarcoma of the pancreas. This vessel must therefore be carefully avoided in going through the mesocolon. Usually the best and safest route to the pancreas is between the stomach and colon, through the lesser omental cavity.

SURGICAL DISEASES OF THE LIVER.

Injuries of the Liver.—The liver is liable to serious injury by crushing, as when a cart-wheel passes over the middle of the body, from blows or falls which break one or more ribs on the right side, or from penetrating wounds.

The **diagnosis** of rupture of the liver, when the abdominal wall is not penetrated, is very difficult. It depends on symptoms of collapse and internal hemorrhage. Dulness in the loin may indicate a collection of blood. The danger is from hemorrhage.

The **treatment** is primarily directed wholly against hemorrhage; hence early exploratory laparotomy is advisable in all cases in which suspicious symptoms follow injuries in that region. Penetrating wounds of the abdomen should always be explored. Wounds of the liver should be treated by suture, ligature, Paquelin cautery, or gauze tampon, as the case may require. The mortality of wounds of the liver has been wonderfully lowered since the above treatment has prevailed —from 86 per cent. to 28 per cent. (Terrier and Auvray).

Abscess of the Liver.[1]—Suppuration in the liver may be due to an injury, to a cholangitis caused by gall-stones, or to parasites. The writer has recently observed a case of actinomycosis of the liver in which two abscesses were opened and drained, with, however, only temporary relief. A more common cause is embolism or pyemia. Infection often takes place through the portal vein in dysentery and other ulcerations of the bowel, in appendicitis, typhoid, and diseases of the rectum.

As a general rule, only single abscesses are favorable for operation. They occur in hot climates and are called tropical abscesses. The Amœbæ dysenteriæ have repeatedly been found in the pus from these abscesses and in the evacuations from the bowels. This explains the frequently noticed sequence of abscess of the liver after dysentery, which is probably its true cause.

Symptoms.—A history of dysentery, pain, and tenderness over the liver, enlargement of the liver, erratic temperature (running from 97° to 103° F.), sweats, chills, and emaciation.

Treatment.—No treatment of this condition is worthy of consideration except complete evacuation of the abscess-cavity, with free drainage. The aspirating-needle should not be used, even for diagnosis, as it is dangerous and unreliable. The liver must be reached by crossing either the pleura or the peritoneum. In either case the serous cavity must be protected. If there are local tenderness, redness, and edema of the skin, it is evident that adhesions exist, and the abscess may be incised directly; otherwise the liver must be exposed by an incision through the abdominal or chest-wall.

The line of incision will be determined by the position of the abscess. If the abscess is in front and points forward, a vertical incision is the best, because it gives an opportunity for opening the abscess at a point sufficiently below the chest-walls to prevent the liver wound from receding behind the ribs when the swelling of the liver subsides. The liver being exposed by a large incision, the peritoneal cavity must be " walled off" by packing sterile gauze between the liver and the abdomi-

[1] See chapter on Tropical Diseases.

nal wall. An aspirator may now be used to locate the abscess, if necessary. The abscess is freely incised, and the cavity wiped out with gauze. It should then be filled with gauze packing and a drainage-tube. Fresh gauze should then be placed between the liver and abdominal wall. Some surgeons advise stitching the liver wound to the abdominal wound, but the liver-tissue is too friable for reliable stitching, and the gauze packing is perfectly safe. The gauze in the liver wound is changed every day and is rapidly diminished in amount; but the protective gauze is allowed to remain five to seven days for the sake of forming strong peritoneal adhesions about the wound.

In passing through the pleura, it is necessary to resect one or more ribs. The opening into the pleura must be carefully made and the parietal pleura secured. The diaphragmatic pleura is next incised, and the cut margins of both pleuræ are stitched together so as to close the pleural cavity, leaving a passage through it to the diaphragm. The diaphragm is then incised, and the liver-abscess may be searched for and drained as in the first instance.

The danger of the operation is not great, as the pus is often sterile. Johnston reports 5 cases treated in this way with 4 recoveries. Fontan of Toulon favors curetting the abscess-cavity, and reports 40 cases with 80 per cent. of cures.

Hydatids of the Liver.—The hydatid worms are the larvæ of the Tænia echinococcus of the dog. The embryo, freed from its shell by digestion, may burrow through the intestinal wall, or is more commonly carried to the liver by the portal circulation. The disease is common in Australasia, where drinking-water is exposed to contamination by dogs and cattle. Its growth is slow.

The **symptoms** are merely an increase in the size of the liver. The tumor is smooth and elastic, and sometimes the characteristic hydatid tremor may be felt. When suppuration occurs the symptoms are the same as in abscess of the liver.

Treatment.—At the present day there are three operations in vogue for the removal of hydatids of the liver: 1. Operation in two stages. 2. Evacuation of the cyst with drainage. 3. Partial or complete removal of the cyst and closing the abdomen without drainage—intraperitoneal.

1. *Operation in two stages* (Volkmann) aims at causing adhesions to form between the liver and the parietal peritoneum as a result of the first operation, so that the contents of the cyst can be removed at the second without infection of the peritoneum. This operation is going out of use, because the one-stage operations are superior.

2. *Evacuation of the Cyst and Drainage.*—A longitudinal incision is made over the abdominal part of the swelling when possible. The liver is examined through this incision, which may be enlarged to suit the condition found.

The space between the liver and the abdominal wall is packed with sterilized gauze to prevent extravasation of the fluid. As much of the fluid as possible is drawn off with a cannula. The cyst is now incised, evacuated, and wiped out. The cyst-walls are then sutured to the abdominal wound, and the cyst-cavity packed lightly with gauze and a large rubber drainage-tube.

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The after-treatment consists in keeping the cyst-cavity clean and gradually diminishing the amount of gauze packing at each dressing.

3. *Intraperitoneal Operation.*—In 1891 Bond of Leicester noticed that there was an elastic cyst inside the fibrous adventitia, and that after drawing off the fluid the elastic lining shrank and could easily be removed. He found that by simply removing the daughter-cysts and the parasite endocyst, which has no organic connection with the adventitious cyst, and by not making any attempt to remove or separate from surrounding parts the latter fibrous investment, the danger from hemorrhage was avoided. He therefore advocates treating all hydatid cysts, dead or alive, which are not suppurating, by evacuation of the contents and closure of the abdominal wound without drainage. He reports 3 cases cured by this operation.

Favorable cases are reported by Hamilton Russell, Byan, and others. Wilmore of Melbourne reports 3 favorable cases. He left the two incisions, even when the cyst was empty, in contact with each other, so that the cyst could easily be drained later if necessary. The adventitia can be inverted and sutured in large cysts or anchored to the abdominal wall near the wound.

Hernia after this operation is, of course, much less frequent than in cases where the cyst is drained. Syme reports a case by Bond's method in which bile leaked and came to the surface, and the patient recovered.

One or two fatal results have also been reported from the intraperitoneal operation. From the reported cases the mortality does not appear to be greater than that following the usual operation of drainage.

Rarely the cysts are pediculated and can be excised *in toto* with more or less liver-tissue. The procedure in such cases is the same as excision of part of the liver for tumor, and the reader is therefore referred to that heading.

Hydatids on the upper surface of the liver must be evacuated through the pleural cavity. The operation for this condition is identical with the operation for hepatic abscess in the same situation already described.

Tumor of the Liver; Excision of Portions of the Liver.— Great progress has been made in the last few years in the technic of resecting tumors of the liver, and the immediate results of such operations have been astonishingly good. The organ is so friable, so full of gaping vessels, and so evidently incapable of being sutured, that it has always seemed impossible successfully to manage large wounds in its substance. In fact, Elder, in 1886, gives the mortality of liver wounds as 62 per cent. The new departure is based on the results of experiments on animals by Glück (1883), Ponfick (1890), Meister, and others.

These experiments showed that large pieces of liver could be removed from rabbits without causing death. In cats and dogs the removal of more than three-quarters of the liver was not followed by any serious consequences. Not only could the animals bear the loss of a large part of the liver, but the organ had the power of regeneration. Meister found that after three-quarters of the liver had been resected, the regeneration was so rapid that it regained its normal weight in thirty-six days.

Bruns, in the Franco-German war (1870), was the first to resect a small portion of the liver in man. The case was of a soldier who had received a bullet wound in the abdomen, through which a piece of liver the size of a nut protruded. This was successfully cut away.

More or less extensive resection of liver-substance in the removal of echinococcus-cysts has been done by Landouzy and Segon, Loreta, Pozzi, and Ruggi, all of whom stitched the liver wound to the abdominal wound. Also less extensive resection by Vohtz and Tansini, who stitched the liver wound together and closed the abdomen. Terrillon operated in two

PLATE 5.
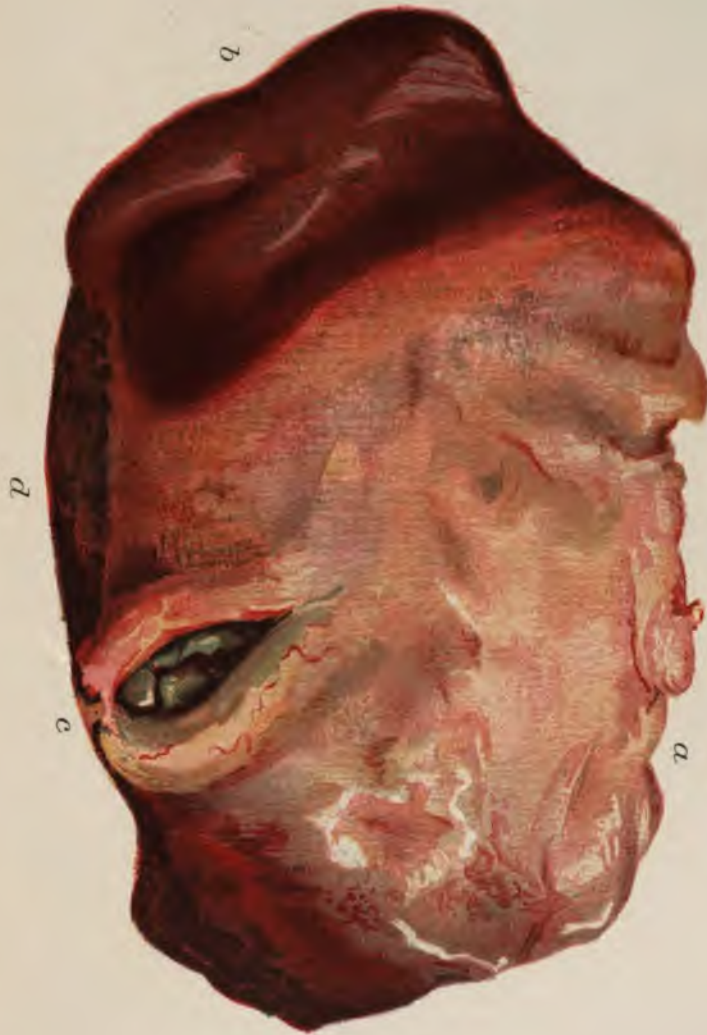
Alveolar sarcoma of the liver: *a*, sarcomatous portion; *b*, healthy liver; *c*, gall-bladder with gall-stones; *d*, cut surface of liver made by the cautery in removing the tumor.

stages, bringing the cyst outside the abdomen and strangulating the pedicle with an elastic ligature, and cutting it away at a later operation. Strange to say, all these cases recovered, although the resection of liver-substance was quite extensive, notably in the cases of Loreta and Pozzi.

Since Ponfick's article, in 1890, a number of operations for various kinds of hepatic tumors have been done by various methods. In 46 reported cases more or less liver-substance was resected for tumor. Nine cases were echinococcus-cysts, to which reference has already been made. Several other cases are not included here. Nine cases were for syphilitic nodules; 2 died.

On account of the favorable results from constitutional treatment, Segond and Bergmann advise against operating on syphilitic tumor of the liver.

Eight cases have been operated on for cancer by Bruns, Hochenegg, Lücke, Jacobs, Watson, M. Robson, and Heidenhain. One case by Küster died from septicemia. In Watson's case the disease recurred in two months. In Jacobs's case recurrence in seven months. In Hochenegg's case there was no recurrence after eighteen months.

In Lücke's case there was no recurrence after two years. The patient was a woman, thirty-one years old. The tumor, the size of a fist, started 2 fingers' breadth below the xiphoid process, and was quite movable. Diagnosis of probable liver-tumor was reached. At the operation a cancer of the left lobe of the liver appeared, which was connected with the liver by a pedicle 20 centimeters (8 inches) in circumference. This pedicle was fastened into the abdominal wound and surrounded by iodoform gauze, over which was placed an elastic ligature. Three days later a tighter ligature was put on. After nine days the remaining pedicle was cut with the thermocautery.

Only primary cancer in a single nodule is suitable for operation: also primary cancer of the gall-bladder which has extended to liver-substance. Such were the cases of Hochenegg, Watson, Robson, and Heidenhain. The latter excised a cancerous gall-bladder with a wedge-shaped piece of infected liver 10 by 12 centimeters (4 by 4½ inches). The liver wound was packed with gauze. Recovery. Lücke's case is astonishingly favorable, and I think should lead to a further trial of excision of primary cancer of the liver.

Four cases were for sarcoma. They were by Bardeleben, Sklifossowsky, Israel, and Elliot. Israel removed a sarcoma weighing 1225 grams (44 ounces) from a girl of fifteen. Israel's and Elliot's cases died in four months from recurrence. In the writer's case, about one-fifth of the whole liver was removed. The wound-surface of the liver was 5 inches long and 2 inches broad. Bleeding was controlled by ligature and gauze pressure. The pedicle was dropped and surrounded with gauze packing. The patient made a good recovery and lived four months. The disease returned on the intestine. There was no recurrence in the liver. Bardeleben's case was well two years after the operation.

If, then, we consider all the malignant cases together, we have 12 cases operated on, with 1 death, and 2 patients were known to have no recurrence of the disease after two years. This is certainly a more encouraging beginning than could have been expected.

There are 4 cases of adenoma operated on by Lius, Bergmann, Tricomi, and Goubé.

Six cases of cysts of the liver have been operated on by König, Muller, Keen—and, according to Bergmann—Terrillon, North, and Lius.

Tiffany removed a nodule, containing a small amount of fine biliary calcareous matter, from the convex surface of the liver.

Eiselsberg operated on a cavernoma hepatis, a unique case. Keen (case not reported) has successfully removed an angioma by elastic constriction, external to the abdominal wall.

From an analysis of these 46 cases it appears that only 4 died, giving a mortality of less than 10 per cent. The tumors have varied in size from a small nut to three fists. In Israel's case the tumor weighed 1225 grams.

Symptoms and Diagnosis.—The symptoms were not usually characteristic or suggestive. The patients were often in a debilitated condition, and many complained of pain in the region of the tumor. They often noticed a sense of weight and fulness in the right side. Several suffered from gastric disturbances and even vomiting, probably due to pressure on or adhesions to the stomach. The tumor varied in its situation according as it arose from the different liver lobes. A tumor of the right lobe was found in the right loin, in the kidney region; while a growth from the left lobe appeared in the epigastric or umbilical region.

The tumors were movable, even when connected by a broad base, and usually more so in a lateral than in a vertical direction. Almost all moved with the respiration. By palpation a direct connection with the liver was occasionally made out; but in more than half the cases percussion showed a tympanitic zone between the tumor and the liver.

The diagnosis was made in only a few cases. The tumors were mistaken for tumor of the pancreas, mesentery, omentum, pylorus, colon, ovary, and kidney. A tumor of the right lobe can often be grasped with one hand in the loin and the other in front, and moved about freely; under which circumstances it may feel exactly like a kidney, as in my case.

Operative Technic.—In the majority of the cases reported the liver-substance was cut with the thermocautery and the large vessels tied. In a few cases the knife or scissors were used. Keen enucleated the tumor with his finger-nail. In several cases the stump was strangulated with an elastic ligature or tied in sections with silk. Gauze pressed against the wound was often effective in stopping the general oozing.

Israel, in operating on a large sarcoma, found that gauze pressure did not control the bleeding; he therefore wound an elastic tube twice around the whole right lobe, which completely stopped the hemorrhage. He then passed three compressing ligatures of stout silk through the whole thickness of the right lobe. This drew the tissues pretty firmly together.

There are four methods of treating the liver wounds.

(1) Closing the abdomen after stopping the bleeding and sewing the liver wound when possible and dropping the stump (intraperitoneal).

This method was followed by Bruns, Langenbuch, Wagner, Lius, Vohtz, Keen, and others. Lius's and Wagner's cases died of hemorrhage, and Langenbuch's case was only saved by reopening the abdomen and retying the vessels. This, then, is evidently a very unsafe method, except, possibly, for small tumors.

(2) Operation in two sittings (extraperitoneal). Tillmans fixed the liver to the abdominal wound, and destroyed the growth with the cautery. Lücke fastened the pedicle into the abdominal wound, and surrounded it with an elastic ligature. It was cut away on the ninth day with the cautery. Terrillon used the same method.

Lauenstein operated in two stages, and the patient died of septicemia on the twelfth day. Küster reports a death from septicemia due to this method.

(3) Fixing the stump into the abdominal wound (extraperitoneal).

In many cases the stump, after having been tied in sections or even with an elastic ligature, was sewed into the abdominal wound, and allowed to granulate under an iodoform-gauze dressing.

Hochenegg and Rosenthal fastened the stump into the abdominal wound by transfixing it with a long needle resting on the abdominal walls. Hochenegg controlled hemorrhage by holding gauze in the liver wound by tying stitches over it. This method has the serious defect that the liver is pulled out of its position, which may injure the organ; it also causes a constant tendency to tear out the stitches— every respiratory movement pressing directly on the wound.

(4) Liver wound packed with gauze and dropped into the abdomen. Abdominal wound partly closed (intraperitoneal).

Eiselsberg first practised this method with success, and Bergmann soon followed and insisted on its value. Israel, Mikulicz, and Heidenhain have also used this method with success.

Gauze packing is one of the greatest advances in abdominal surgery, and I feel certain that its use in liver wounds is going to prove of great value. In fact, it seems to me to have settled the treatment of these wounds for some time to come, if not for all time.

It appears, then, that it is unsafe to drop a large pedicle and close the abdominal wound on account of the danger of hemorrhage; that bringing the tumor out through the abdominal wound and slowly strangulating it with an elastic ligature around its base is liable to give rise to septicemia; that fastening the pedicle into the abdominal wound may injure the liver, and make the edges of the wound liable to pull away on account of the cutting of the stitches.

In my opinion, the best procedure is to use a rubber tube for a tourniquet during the operation if necessary; to tie all the large vessels separately, using gauze pressure for the oozing; to close the liver wound as much as possible with sutures; to drop the stump inside the abdomen and to surround it completely with sterilized gauze, packing iodoform gauze against the liver wound, and leave the abdominal wound sufficiently open to facilitate dressing the liver wound.

Hepatoptosis.—The subject of "floating liver" has lately been treated by Terrier and Auvray in *Revue de Chirurgie*, 1897, and commented on by Binnie in *Annals of Surgery*, January, 1898. According to these writers, Landau believes that the primary defect is a distention of the abdominal walls; but Glenard thinks the intestines are an important support to the liver, the anterior abdominal wall being their *point d'appui*. Faure thinks the inferior vena cava important among the supporters of the liver.

"Floating lobes" of the liver have occasionally been noticed at operations. Riedel has shown that gall-bladder disease may cause such a condition.

The position taken by the displaced liver varies greatly. Demarquay found the liver turned upside down, with the gall-bladder next the diaphragm.

Griffiths and Tiush found the liver rotated on its transverse axis, its superior surface being against the abdominal wall, and its anterior border in the iliac fossa. Heisher and Binnie found the convex surface of the liver lying in the right flank, the anterior edge being vertical and the inferior surface facing to the left. Kirmisson found a liver dislocated to the

opposite side of the abdomen. Crawford found the liver completely anteverted and lying on the intestines in the long axis of the abdomen, the lower edge of the right lobe a hand's breadth below the costal margin.

The abdominal walls are often flabby or hanging.

The disease is often associated with abnormal mobility of the other abdominal organs.

The actual causes of hepatoptosis are usually strains, heavy work, violent exercise, etc. A pendulous condition of the belly-wall following pregnancy is a common cause.

Symptoms and Diagnosis.—" Floating lobes " often cause considerable pain. Their diagnosis consists in demonstrating the presence of a tumor of slow growth which is connected with the liver. The differentiation from other tumors of the liver is difficult or impossible.

When complete hepatoptosis occurs suddenly, as during a fit of coughing or from traumatism, there is often a biliary colic and feelings of tearing and torsion in the right side. There may be difficulty of respiration, nausea, feeling of fulness in the abdomen, and tendency to syncope.

When it occurs slowly there is a feeling of weight and dragging, which is increased by exercise. There is a dull, aching pain in the back, extending up between the shoulders. Jaundice is often present. In the later stages there are pain and tenderness over the liver, ascites, swelling of the legs, and, finally, acute abdominal pain and local peritonitis.

Crawford reports a case with autopsy where the liver was anteverted. This caused obstruction of the bile-ducts and of the portal circulation. There was therefore degeneration of the liver-cells and edema of the liver, with jaundice, ascites, edema of the legs, emaciation, diarrhea, and, finally, death.

The author recently operated on a lady who was wholly disabled, the prominent symptom being pain in a tumor which occupied the right loin. The diagnosis of enlarged movable kidney seemed the most probable. A lumbar incision showed the kidney to be normal, but dragged out of place by a tumor which rested on the pelvis. On incising the peritoneum the tumor proved to be the liver, the right lobe of which was easily turned out through the lumbar incision as far as the gall-bladder. The abdomen was then opened in front by the ordinary incision for cholecystotomy. A gall-stone was removed from the gall-bladder. The liver was then pushed up into its normal position, and held there by firmly stitching the gall-bladder to the abdominal wall (cholecystotomy). The patient was restored to health by the operation.

The liver can usually be made out in its new position by palpation and percussion.

Glenard calls attention to a diagnostic point by noting that the lower part of the umbilicus is hidden by a fold of skin, which is due to traction of the liver on the suspensory ligament.

The **treatment** of partial hepatoptosis has been carried out in three ways: (*a*) By resection of the " floating lobe." (*b*) By fixation to the abdominal wall. (*c*) By cholecystotomy, in the hope of indirectly diminishing the lobe.

Langenbuch resected a lobe in 1887.

Billroth stitched a "floating lobe" to the abdominal wall in 1884.

Complete hepatoptosis has been treated by bandages to hold the liver in place, but they are often uncomfortable and have to be abandoned. In severe cases operation seems to be necessary to save life.

The *operation* of stitching the liver to the abdominal wall is called *hepatopexy*, and was first done by Marchant in 1891. According to Binnie, it has now been done 15 times. The abdominal incisions have been either vertical in the median line, at the outer border of the rectus, or parallel to the costal arch. The liver is returned to its normal position, and fixed there by sutures. The sutures are passed through the liver-substance and into the tissue under the right costal margin or into the abdominal wall. Blunt needles and coarse catgut have been used. From 2 to 8 stitches are placed.

Depage considers hepatopexy of secondary importance to laparectomy in these cases. He excises portions of the abdominal wall transversely and vertically to overcome the laxity of the belly-walls and to gain support. This is probably the best operation.

According to Binnie, from 11 cases of hepatopexy (alone) there were 8 recoveries and 1 death, the result of 2 being uncertain. "In the 8 cases the condition was rendered very satisfactory and maintained in this state."

SURGICAL DISEASES OF THE GALL-BLADDER AND BILIARY PASSAGES.

The most important surgical diseases of these parts are cholelithiasis, cholangitis, and cancer.

Cholelithiasis.—There are two theories as to the cause of gallstones. According to one, held by Bouchard and others, they are formed by precipitation of the cholesterin from special chemical changes in the bile. According to the other, held by Naunyn and others, they are formed by a catarrhal condition of the bile-ducts. This causes a separation of cholesterin and other salts and increases their quantity. Naunyn has found bacteria in intrahepatic calculi, which suggests that the catarrh which caused their formation had a microbic origin.

When the hepatic or common duct is obstructed, the back-pressure of the bile causes a destructive process in the liver-substance; and Nasse has shown by experiments on animals, that as soon as that back-pressure is relieved the liver-cells are actually capable of regeneration. Obstruction of the ducts is almost always followed by bacterial infection of the bile, which usually disappears when the passages are opened. Thus we find abundant scientific encouragement for the removal of calculi.

Symptoms.—Gall-stones cause two entirely different sets of symptoms, according as they are situated in the gall-bladder and cystic duct or in the common and hepatic ducts. When they are located in the gall-bladder or cystic duct they give rise to painful contractions and enlargement of the gall-bladder, which in time becomes chronically thickened and often ulcerated. Adhesions form about such a gallbladder and cause symptoms of local inflammation. Such a gall-blad-

der may become infected, causing an acute phlegmon and even gangrene with peritonitis and death.

The usual history of these cases is of occasional attacks of pain and inflammation in the gall-bladder region, more or less severe, either without any jaundice or with only slight jaundice.

When the stones are located in the hepatic or common duct, important functions of the liver are threatened, and the symptoms become more serious. Here the flow of bile is obstructed, giving rise to jaundice. It is characteristic of gall-stone obstruction that the jaundice is intermittent or remittent. This is due to the passing on or moving back of the stones (ball-valve action of a floating stone—Fenger) or to relaxation of a spasm of the duct.

With the onset of the jaundice there are usually colic and a rise of temperature. The colic is due to a spasm of the duct or gall-bladder; while the rise of temperature is probably due to septic absorption caused by a temporary retention of the septic bile. After several months there is nearly always a marked loss in weight, due to impairment of important functions of the liver. Clay-colored stools show that no bile reaches the intestine.

Obstruction of the ducts by cancer causes a permanent jaundice. Intense and continuous jaundice suggests obstruction by tumor; but jaundice extending over a number of years indicates obstruction by stone, because a malignant tumor would have become evident in less time.

Operative Treatment.—An operation is indicated, in our opinion, whenever the above symptoms are present to such a degree as to make it probable that a stone is present which will not pass. It is to be remembered that when stones are present the bile is usually infected with bacteria, and that the patient is subjected to a slow, destructive process in the gall-bladder or liver, and is always liable to an acute infection.

The principal contra-indication (besides the general surgical contra-indications) is a hemorrhagic diathesis. Severe icterus causes such a condition, and many cases operated upon for gall-stones have proved fatal on that account. It is therefore necessary to investigate this point before operating. Mayo Robson gives calcium chlorid to deeply jaundiced patients, before operation, in 30-grain doses, "to make the blood more plastic and to lessen the tendency to bleeding."

Cholecystotomy is the operation most frequently done for gall-stones.

For all gall-stone operations I think it is best to use the reversed Trendelenburg position. The patient is hung by straps under the arms on an inclined plane, at an angle of something less than 45 degrees. A sand-bag is placed under the back so that the patient is bent over it. In this position the intestines gravitate to the lower part of the abdomen, so that when the liver is held up by a retractor, the air sucks in between the liver and intestines much as it enters the pelvis in the Trendelenburg position. This position makes it possible to see and manipulate the gall-bladder and ducts.

The abdomen is opened in the right linea semilunaris. Kocher employs an oblique incision parallel to the right costal margin. If the gall-bladder is found distended, it is aspirated and then opened, the parts being isolated by sterilized gauze. If stones are present, they are easily removed with forceps or fingers. The cystic duct is next

examined by passing the hand down beside the gall-bladder along the duct; in this way stones can usually be felt in the duct and manipulated back into the gall-bladder. Sometimes it is useful to pass an instrument into the duct, guided by the right hand outside. Stones impacted in the duct can often be removed by a curet or a scoop, or by milking the duct. If, however, their removal requires much manipulation, it is safer to incise the duct at the point of impaction. When the ducts are clear, or when it seems advisable to stop the operation, the opening in the gall-bladder is stitched into the abdominal wound and a rubber drainage-tube is placed in the gall-bladder. It is advisable to stitch the gall-bladder to the peritoneum or aponeurotic layer and not to the skin, as being less liable to leave a permanent fistula. In ordinary cases the drainage-tube is removed after five or six days, and the opening allowed to close. Terrier suggests that in cases of suppurative cholangitis the discharge should be tested bacteriologically, and that the tube should not be removed until the bile is sterile or nearly so. A purse-string suture passed around the opening in the gall-bladder at the operation may be tightened seven or eight days later. This will materially shorten the duration of the bile-fistula, if it is desirable to do so.

In cases of long-standing disease the gall-bladder may be found embedded in adhesions, so that all anatomical landmarks seem to be lost; when reached, the gall-bladder is often found to be small and contracted, lying deep under the liver. In such a case it is manifestly impossible to fasten it to the abdominal wall. Here a drainage-tube may be passed into the opening in the gall-bladder and surrounded by sterilized gauze. This leads the bile to the surface, and soon adhesions are formed to protect the peritoneal cavity. In such cases, if the ducts are known to be clear and free from severe inflammation, I think it is safer to do a cholecystectomy. The mortality of cholecystotomy is usually put at about 15 per cent., but Kehr reports a mortality of about 1 per cent. Mayo Robson reports about the same for simple cases.

"*Ideal*" *cholecystotomy* consists in closing the opening in the gall-bladder with two rows of sutures and returning it into the abdominal cavity, either with or without drainage. This operation has the advantage of avoiding a temporary biliary fistula. It can only be used when the gall-bladder is healthy and the ducts are not obstructed. This is a safe operation in proper cases.

Cholecystendysis (Courvoisier) consists in closing the opening in the gall-bladder and anchoring it to the abdominal incision, which is closed over it.

The author has employed this method with good results; but in one instance found it necessary to operate a year later to free a painful adhesion between the gall-bladder and the abdominal wall.

Cholecystectomy.—Here the gall-bladder is dissected from the liver. This leaves a pedicle which consists of the cystic duct and the cystic artery, and which can be safely ligated and dropped.

In certain cases, and especially those where the gall-bladder has been inflamed, there is considerable difficulty in freeing it without tearing the liver-substance, and thereby causing troublesome hemorrhage. The author has a modification of the usual operation to offer for such cases. It consists in making no attempt to free the gall-bladder from

the liver, but in leaving that part of the outer coat adjacent to the liver undisturbed. The gall-bladder is cut away down to the level of the liver, and the mucous membrane, which peels off easily, is the only layer removed from the liver.

The mortality is usually given as 17 per cent. Kehr reports 21 cases with 1 death—5 per cent., which is probably nearer the true mortality.

After examining the gall-bladder and cystic duct, the next step is to examine the common duct and the hepatic duct. If the gall-bladder is drawn upon, it exerts a slight tension on the gall-ducts and makes it easier to follow them with the fingers. After the thumb and forefinger of the left hand have glided over the cystic duct, the forefinger is passed into the foramen of Winslow, and the thumb naturally comes down on the ligamentum hepatoduodenale. The common duct is now held between the thumb and forefinger, and can be palpated down-

FIG. 237.—The duct is held by the thumb and forefinger of the left hand. The stitches are placed before the stone is removed.

ward to the duodenum or upward to the hepatic duct, and even back to the liver.

If a stone is found in the duct, an attempt should always be made to push the stone back into the cystic duct or forward to the duodenum, and to crush it between the fingers (cholelithotrity). This is not infrequently successful. Mayo Robson succeeded in crushing a stone with his fingers in 27 cases. Stones in the duct have also been broken up by needling and by crushing with padded forceps; but this is a method by which the duct might be seriously injured without the knowledge of the operator.

Choledochotomy.—If the stone cannot be moved or crushed with the fingers, the duct must be incised. The stone in the duct is grasped with the thumb and forefinger of the left hand and raised to as convenient a level as possible. The peritoneal cavity should be shut off with gauze packing. The fingers should not be removed from the duct until the stitches are tied. The duct is incised over the stone by a

longitudinal cut. The stitches are then placed in the sides of the duct before the stone is removed (Fig. 237), for the instant the stone is removed the duct collapses, and the wound is bathed in bile and cannot

FIG. 238.—Incision in choledochotomy (Halsted).
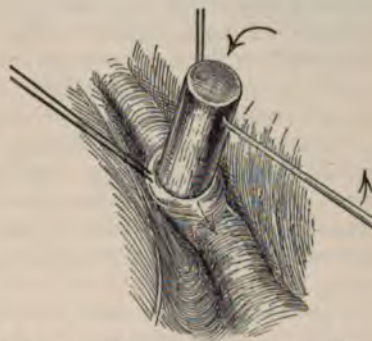
FIG. 239.—The introduction of the hammer into the duct (Halsted).

be brought into an accessible position again. As the stone is removed the fingers may squeeze the duct above to prevent the flow of bile before the stitches are tightened; at this point a sound can easily be
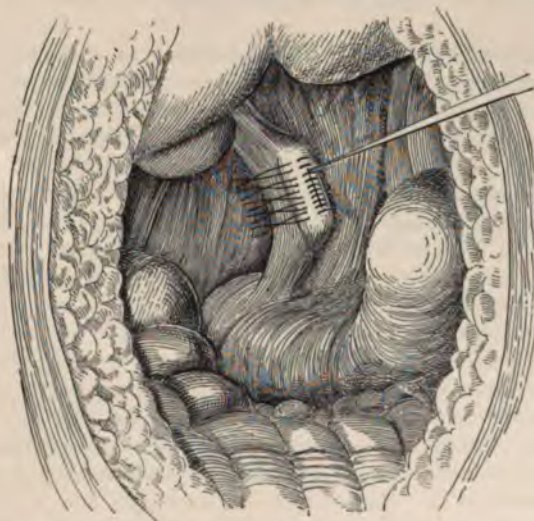
FIG. 240.—Suture of the duct over the hammer (Halsted).

passed into the duct to ascertain if it is clear. Two rows of stitches are placed—very fine catgut being used for the duct itself, and silk for the overlying peritoneum. A small drainage-tube is passed down to the duct and surrounded with sterile gauze. By this method the

author has succeeded in closing the hepatic duct once and the common duct three times, so that no bile escaped after the operation.

Halsted has devised miniature hammers (Figs. 238–241) to facilitate suture of the ducts. The head of the hammer is inserted into the incised duct, while the handle is used to pull the duct forward. The hammer-head gently distends the duct and allows the sutures to be taken with precision; it also stops the flow of bile while the sutures are being placed. The handle is placed near one end of the head of the hammer, to enable the operator to introduce it through as small an incision as possible. There are several sizes of the hammer to match the varying sizes of the duct.

If it is found impossible to suture the duct, a drainage-tube surrounded with gauze may be placed down to the open duct. This has often been done with success; but I find the mortality of choledochotomy without suture of the duct is somewhat higher than with perfect suture. The mortality of the operation is from 18 to 23 per cent.

Choledochoduodenotomy.—In this operation the duodenum is opened to remove a calculus from the very end of the bile-duct. It has been done with success by McBurney, Pozzi, and Kocher.

FIG. 241.—Halsted's hammer.

Cholecystenterostomy consists in establishing an opening between the gall-bladder and the intestine, usually in the duodenum or colon. This brings the bile into the intestine even if the common duct is obliterated.

This operation may be done by suturing, but Murphy's button has given by far the lowest mortality, and is altogether the best known method of making this opening. The manner of placing the button is described under Intestinal Operations.

According to Mayo Robson, Murphy has collected 67 non-malignant cases, with 3 deaths; 12 malignant cases, 10 deaths. Mortality, 83.3 per cent. for malignant cases.

Remarks on the Operations.—Before the abdomen is opened one never knows which of the above operations will be suitable for the case in hand. In a general way, it may be said that every operation should be conducted with the idea of ultimately restoring the functions of the bile-ducts, and that any irreparable injury to them is a serious calamity; also that patients bear the operation better when we are successful in clearing the ducts.

Cholecystotomy is done much more frequently than any of the other operations. By this procedure the gall-bladder and cystic duct can be cleared of calculi and drained. In case of obstruction of the common duct, the liver can be relieved of the back-pressure of bile and the system of the deleterious effects of bile-absorption; moreover, in case of cholangitis, the infected ducts are drained. The disadvantages of the operation are the formation of adhesions, often painful; the nuisance

of a biliary fistula, and the deprivation to the digestive process of bile in the intestine. The last is not so important as was at first supposed, as it is now known that the bile is largely an excretion of waste-products of the liver, and that patients with biliary fistulæ live a long time with fairly good digestion. Moreover, we can give such patients ox-gall, if desirable.

After cholecystotomy, stones left in the ducts, accidentally or from fear of prolonging the operation in a feeble patient, often work loose and come out or are washed out. When the ducts are clear the fistula usually closes spontaneously.

On the other hand, there is not infrequently an opportunity to close the gall-bladder at once ("*ideal*" *cholecystotomy*). Such an opportunity presents itself, most often in recent cases, when the gall-bladder is found healthy and when the deep ducts are clear, which may be considered a fact if the patient has had little or no jaundice and if no stones are detected by a systematic palpation of the ducts. "Ideal" cholecystotomy is, as its name implies, the perfection of gall-stone operations in proper cases. More and more favorable cases are being reported. The author has done the operation five times with most favorable results.

A gall-bladder distended with bile indicates a movable stone in the cystic duct. A gall-bladder distended with clear, white fluid indicates a complete obstruction of the cystic duct of long standing. When the gall-bladder is thickened and phlegmonous or gangrenous, there is almost certainly a stone obstructing the cystic duct. When the gall-bladder is contracted or nearly obliterated, there is usually a stone in the common duct.

Cholecystectomy, like "ideal" cholecystotomy, should only be done when the common duct is clear. It is indicated when the gall-bladder is so diseased that its function cannot be restored; also when there is an irremediable obstruction of the cystic duct. In acute phlegmon or gangrene of the gall-bladder, it is usually safe to do a primary cholecystotomy, and later, when the acute symptoms have subsided, a cholecystectomy. If there is jaundice, a very careful search should be made for an obstruction of the hepatic or common duct.

Choledochotomy with suture of the duct is the operation of choice for a stone in the duct which cannot be moved or crushed with the fingers. If the patient is in a critical condition, it is usually wiser to do a primary cholecystotomy. This will allow the liver to resume its functions to a certain extent, and will prevent bile-pressure from complicating a choledochotomy done at a later date. Choledochotomy under such circumstances is relieved of many of its dangers. Kehr and Mayo Robson think that a cholecystotomy should always be done coincidently with, if not before, choledochotomy. It relieves the stitches from bile-pressure, drains the diseased ducts, and is a safety-valve in case calculi remain undetected. Choledochotomy with suture of the duct should never be attempted without cholecystotomy, except in recent cases and when the operator is certain that he has succeeded in clearing the duct to the duodenum.

When the hepatic duct is incised, cholecystotomy is of no advantage if the common duct is clear. The writer on one occasion succeeded

in removing a stone from the hepatic duct and closing the incision with sutures, which he believes is the only case on record.

When there is an irremediable stenosis of the common duct, such as might be caused by a stricture or cancer of the head of the pancreas, *cholecystenterostomy* is indicated. Unfortunately, the mortality of this operation is very high—85 per cent.—when done for malignant disease; hence it cannot be recommended in those cases. It is therefore most valuable in cases of simple stricture of the common duct, which are very rare. The objections to cholecystenterostomy for gall-stones are that it leaves the stones still irritating the ducts and makes an abnormal opening in the bile-passages, which may become infected by intestinal bacteria, or it may contract and thereby become useless.

Cholangitis.—It has already been stated that obstructed bile soon becomes infected with bacteria, and that such infection is an important incident in the symptoms and treatment of gall-stones. Other forms of obstruction give rise to infective cholangitis—notably cancer of the ampulla of Vater.

Recently the relation of typhoid fever to cholangitis and cholecystitis has been studied by numerous bacteriologists, especially by Chiari, who found the typhoid bacillus in the bile-passages of 19 out of 22 cases of typhoid examined. There are also numerous cases reported which show that cholecystitis and cholangitis occur as complications and sequelæ of typhoid. Among these cases there are several where a peritonitis, supposed to be due to perforation of a typhoid ulcer, proved to be due to perforation of a gall-bladder. Osler concludes a recent paper as follows: "Infection of the bile-passages with the typhoid bacillus may, as we have seen, be perfectly harmless; that is to say, the gall-bladder may show no signs of even catarrh; in other instances intense cholecystitis may be excited; while in a third group the so-called lithogenous catarrh may develop from the irritation of the bacilli, leading to the formation of gall-stones."

Symptoms.—Fever, with occasional rigors, profuse perspiration, rapid loss of flesh, pain and tenderness in the region of the gall-bladder, and usually jaundice. Pain and tenderness in the region of the gall-bladder, with or without jaundice, during or after typhoid should excite suspicion. Peritonitis starting in the gall-bladder region during or after typhoid is suggestive of rupture of the gall-bladder.

Treatment.—Cholecystotomy should be done and free drainage established. Calculi should always be looked for.

Terrier suggests that the drainage should be continued until bacteriological examination of the discharge shows it to be sterile.

Cancer.—Cancer of the biliary passages is usually caused by the irritation of gall-stones.

In cancer of the gall-bladder the most characteristic sign is the presence of a hard tumor which is not tender. When this disease appears in the ducts they are obstructed, and the symptoms are almost identical with those due to gall-stones, it being almost impossible to distinguish them in the early stages.

Cancer of the gall-bladder or cystic duct can be excised with the organ, and even when the disease has extended to the liver the case is not altogether hopeless. As we have already seen, several cases are

reported in which the gall-bladder and adjacent infected portions of the liver were excised with success.

Cancer of the ducts is most common at the ampulla of Vater. Here we have early symptoms of bile-obstruction, and, later, suppurative cholangitis is a common occurrence. The disease in these cases is at first only a small nodule, and might conceivably be excised (although it has never been done). The only surgical relief that can be given is by either a cholecystotomy or a cholecystenterostomy.

SURGICAL DISEASES OF THE PANCREAS.

Pancreatic cysts used to be considered as simple retention-cysts due to obstruction of the ducts. Lloyd has called the cysts which appear soon after an injury in the region of the pancreas pseudocysts. He thinks that by a blow on the upper abdomen the pancreas is jammed against the spine, and the overlying peritoneum is broken, allowing blood to flow into the lesser omental cavity. This in small quantities may be absorbed; but when mixed with pancreatic secretion from ruptured ducts irritates and thickens the peritoneal covering of this cavity, giving it the appearance of a true cyst of the pancreas. The fact that pancreatic cysts sometimes follow injuries in that region is in accord with such a theory of their origin.

Fisher thinks that all the so-called pancreatic cysts are primarily collections of blood between the blades of the mesocolon of the transverse colon. Such a cyst may push into the lesser omental cavity or into the peritoneal cavity.

According to Heinricius, Berg thinks that the acute forms of pancreatic cysts are formed in the same way as ranulæ in the mouth—*i. e.*, the secretion from an injured duct of the gland flows into the loose cellular tissue, where it becomes encapsuled by gland-tissue and grows. Such a theory would explain the difficulty of removing the cysts and the gland-tissue sometimes found about them. Heinricius has collected and analyzed 92 cases which were operated on. Judging from the descriptions given, he considers that 11 cases were true cystic new growths, 5 cases were echinococcus-cysts, 36 cases were true cysts, and all the rest were pseudocysts.

Cysts usually come from the body or tail of the pancreas, seldom from the head. Traumatic cysts may appear quickly; but in a few cases they have appeared after eight years. They are usually small; but occasionally they become very large.

The cyst usually pushes into the omental bursæ and presses up behind the stomach; or it may grow in between the blades of the transverse mesocolon, in which case the colon itself may be pushed either up or down.

These cysts are usually found, when small, in the left upper abdomen, fluctuating and movable but not tender.

Errors in diagnosis are very common. Even the fluid often fails to show the peculiarities of pancreas-secretions, and von Jaksch has shown that ascitic fluid may present the characteristic sugar-reaction. Inflation of the stomach and colon may be useful in determining their relative position.

Treatment.—The proper treatment is incision and drainage; only occasionally is there an opportunity for total extirpation. For a rapidly forming effusion into the omental bursa immediate laparotomy should be done, in the hope of ligating a bleeding point or packing the injured pancreas with gauze.

The incision should be over the swelling, usually vertical, in the middle line or to the left of the rectus muscle. The lesser omental bursa is opened by dividing the gastrocolic omentum. If it is a pseudo-cyst, the cavity is simply packed with a drainage-tube surrounded with gauze. If a cyst-wall appears, it is necessary to free the adhesions, if present, and to discover if there is a pedicle. In case of a pedicle which can be tied or sewed, total extirpation should be tried. If there is no pedicle, incision and drainage are the proper treatment, in which case the cyst-wall should be stitched to the abdominal wall.

Among the cases collected by Heinricius (1897) there were 65 cases in which the cyst was drained, most of which healed without leaving a fistula. In 1 a fistula remained after five years; 7 died.

Total extirpation may be very difficult, especially when pancreatic tissue is spread out over the cyst-wall. Sometimes operators have been obliged to abandon total and do a partial extirpation. Of the 13 cases of total extirpation done to date, 2 have died of septic peritonitis and 11 have recovered.

In 3 cases the cyst, having been explored by a laparotomy in front, was drained by an incision under the twelfth rib on the left side, and the abdominal wound was closed. In cases where the cyst is deep, with a broad base, and not easy to bring forward and drain, Leith prefers a primary posterior incision under the twelfth rib. Through this incision the finger is pushed by the upper border of the quadratus muscle, and locates the left kidney and its vessels. The tail of the pancreas and the posterior and outer wall of the omental bursa lie just above and just inside the renal vessels. Here one can enter the lesser omental cavity either through the mesocolon or through the posterior peritoneal layer.

Tumors of the Pancreas.—Ruggi has extirpated a carcinoma of the tail and body of the pancreas.

Krönlein has removed an angiosarcoma of the head of the pancreas. Nevertheless, operations on the pancreas for malignant disease are not advisable, because recurrence will be almost certain if only a part of the organ is removed, and because diabetes follows total extirpation of the organ in animals.

Zendler has removed a tubercular lymph-gland of the pancreas, the patient making a good recovery.

Pancreatitis.—Fitz in his monograph divides pancreatitis into three varieties: hemorrhagic, suppurative, and gangrenous. In the recorded cases of hemorrhagic pancreatitis (exclusive of traumatic cases) death has usually followed the first symptoms so quickly that surgical intervention would have been impossible. It is therefore the suppurative and possibly the gangrenous forms that offer a chance for surgical treatment.

Symptoms.—Fitz gives the following symptoms taken from an analysis of 22 cases: "The cases of acute suppurative pancreatitis

usually begin suddenly with severe gastric, epigastric, or abdominal pain, vomiting, and sometimes great prostration. The ejected fluid is sometimes stringy and brown. The bowels are usually constipated, although diarrhea may occur. Fever, usually slight, comes on at about the third day; at the same time the upper abdomen, especially the epigastrium, becomes distended, tympanitic, and sensitive. Hiccough and chills are occasional symptoms. When death occurs in the course of a week or more the pancreas is sometimes found studded with hundreds of small abscesses. An acute suppurative pancreatitis, however, very rarely terminates at this early date. The symptoms already described may persist for three or four weeks with progressive emaciation and debility, and death occur from exhaustion. Under such circumstances the single abscess has been found surrounded with adhesions."

The local condition, and especially the presence of a tumor, are of importance to the surgeon. The tumor usually represents a pus-collection. The pus is almost always retroperitoneal in the early stages, and not infrequently remains so to the end. In the traumatic cases the peritoneum may be ruptured, in which case the inflammation may begin in the omental bursa. The inflammatory process may start at any point in the pancreas. If it is most intense at the tail, a pus-cavity may form in the left upper abdomen, near the spleen or kidney. If the process attacks the head of the pancreas, the pus-cavity usually breaks into the omental bursa and becomes encapsulated there. At times the parapancreatic tissue is involved, and the whole gland is surrounded by a pus-cavity which extends from the duodenum to the spleen. The pus may break into the general peritoneal cavity or into the duodenum; but it more commonly burrows down behind the peritoneum, and is often found in the mesocolon as low as the pelvis, on either the right or left side. It may also extend into the root of the mesentery.

The writer has seen 4 cases of pancreatitis in which a tumor represented a collection of pus and led to a probable diagnosis in 3 of the 4 cases. Körte, recognizing the surgical importance of a tumor in these cases, has collected 4 cases, besides 3 of his own, where a tumor was observed. I have now records of 11 cases with descriptions of tumors. In 3 the tumor was epigastric. In 3 it was epigastric, extending along the ribs toward the left side. In 3 it was in the left upper abdomen, below the ribs. In 2 cases it was on the right side, below the liver. These tumors were observed in from three and one-half days to one month after the first symptoms.

It will be seen, then, that there are three, and perhaps four, typical forms of tumors which appear in these cases: (1) an epigastric tumor behind the stomach, due to pus in the omental bursa; (2) a tumor running from epigastrium to spleen, just below the ribs, due to an enlarged pancreas or to a parapancreatic abscess; (3) burrowing of a retroperitoneal pancreatic abscess may give rise to a tumor in the left loin or on the right side, below the liver.

These tumors will sometimes be difficult or impossible to feel on account of a tympanitic and painful condition of the abdomen or a fat abdominal wall. As the inflammation is retroperitoneal, they are

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usually indistinct and vague to the touch, and they are often tympanitic on percussion, as the bowel or stomach may lie over them. Such tumors will best be found by careful and gentle palpation. Inflation of the stomach and transverse colon is useful to determine whether a tumor is in front or behind these organs.

Treatment.—As the matter stands to-day, there seems to be good ground for surgical interference in proper cases, but only one successful case has been reported. This case was done by Körte, and consisted in opening and draining, by a lumbar incision, a retroperitoneal abscess in the outer part of the left abdomen. The writer has recently operated successfully on another case (not yet published). In this case the abscess was in the omental bursa. The patient recovered with a pancreatic fistula.

The acute stage is probably an unfavorable time to operate ; at least no recoveries are reported. At present, then, our attention is directed to opening pus-cavities and limiting their extension.

If pus has collected in the omental bursa, the incision should be made in the middle line, from the xiphoid cartilage downward. The bursa is opened by tearing through the omentum between the stomach and transverse colon. The anterior wall of the bursa may be stitched to the abdominal wall before opening, so that the abscess-cavity is shut off from the general peritoneal cavity. If the abscess-cavity extends along the pancreas, a counteropening should be made in the lumbar region, just below the twelfth rib. When the pus is evidently retroperitoneal and burrowing in the lumbar region or in the mesocolon, the opening should be made in the back, as for extirpation of the kidney.

CHAPTER XV.

HERNIA.

GENERAL CONSIDERATIONS.

THE term "hernia" is used to denote the protrusion of any viscus from the cavity which under normal conditions it occupies. While it may be applied to a protrusion of other organs, when used alone it has come to mean a protrusion of one or more of the abdominal viscera through an opening, natural or acquired, in the walls of the cavity, and is synonymous with the more common term "rupture." This term is rarely used in referring to the escape of viscera following a penetrating wound of the abdomen, "protrusion" being the better term for this condition. "Hernia" usually refers to an *external* protrusion of the abdominal viscera, though "internal hernia" is used to characterize certain forms of intestinal obstruction. Hernia may be either *congenital* or *acquired.* When it occurs through an opening in the abdominal wall which, though normally patent in fetal life, has failed to close at birth, it is called *congenital.*

In *acquired* hernia the sac is developed subsequently to birth, and occurs at points where the abdominal wall is by nature relatively weak —*e.g.* at the site of the inguinal and femoral canals and at the umbilicus. The situation of the opening is the basis of the anatomical classification of herniæ: and thus we have inguinal, femoral, umbilical, and ventral as common forms; lumbar, obturator, diaphragmatic, pelvic, perineal, pudendal, and ischiatic as rare varieties.

The hernia may be further characterized by its contents—viz., enterocele, meaning a hernia containing bowel; epiplocele, one containing omentum; and bubonocele, a hernia occupying the inguinal canal alone, not yet having passed outside the external ring.

Mode of Development.—Every hernia, of whatever variety, has a sac, composed of peritoneum, continuous with the parietal peritoneum of the abdominal cavity.

As the hernia enters one of the weak places in the abdominal wall already referred to, the peritoneum is pushed before it, gradually expanding to accommodate itself to the increasing size of the protrusion.

Shape of the Sac.—This varies with the size of the hernia as well as with the anatomical variety. In acquired inguinal hernia the sac at first consists of a funnel-shaped depression at the site of the internal ring; as the hernia advances, it becomes cylindrical or sausage-shaped; and lastly, when it has entered the scrotum or labium, it becomes pyriform. In direct inguinal hernia, as well as in femoral hernia, the sac is usually globular in shape. That portion of the sac situated at the narrowest part of the opening through which the hernia protrudes is called the *neck.* In the inguinal variety this is usually at

the internal ring; in the femoral, at the inner portion of the crural ring. In the early stages of a hernia no distinct neck is present, and it is only when the hernia has emerged from the abdominal opening and become a tumor of appreciable size that the sac may be said to have a true neck. In certain rare cases—*e. g.*, congenital cecal, sigmoid, and a variety of hernia of the bladder—the sac may be more or less deficient.

The character of the sac itself varies greatly. In children, and in herniæ of recent origin in adults, it is very thin and delicate; while in herniæ of long standing, especially if exposed to the more or less constant irritation of a truss, it may be greatly thickened. The lowermost portion of the sac is called the *fundus*. Numerous changes may take place in the sac, due to irritation or inflammation resulting from the presence of an ill-fitting truss—*e. g.*, partial closure of the sac, giving it an hour-glass appearance; or complete closure may occur, in which case the fundus or distal portion of the sac may either remain empty or become filled with serous fluid, thus giving rise to the condition known as *hydrocele of the hernial sac*.

Among the pathological changes that may take place in the sac should be mentioned tuberculous or cancerous infiltration and calcareous degeneration. All of these conditions are rare.

Covering of the Sac.—The tissues overlying the sac constitute the coverings. These vary according to the anatomical variety of the hernia.

Contents of the Sac.—All of the abdominal viscera except the pancreas have been found in the sacs of herniæ. The usual contents of the sac in all forms of hernia consist of omentum or small intestine, either alone or together. More rarely the cecum, sigmoid flexure, or colon is found, and occasionally the bladder and ovaries. When the sac contains bowel alone the hernia is called enterocele; when omentum alone, epiplocele; and when both bowel and omentum, entero-epiplocele. When omentum is present and allowed to remain for any length of time, it is likely to become adherent, and later irreducible.

ETIOLOGY OF HERNIA.

Heredity.—The anatomical defects or conditions predisposing to the development of hernia are undoubtedly in many cases inherited. Macready, who has made a careful study of this question, estimates that 25 per cent. of hernia patients give a history of hernia in ancestors.

Sex.—Hernia is by far more common in the male than in the female, the proportion in inguinal hernia being 6 to 1.[1]

Age.—While hernia occurs at all ages, in a large proportion of cases it develops during the period of infancy. Of 1000 males ruptured, 175 are affected in the first year of life; while of a similar number of females, only 91.6 develop hernia during the first year.[2] About 40

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[1] An analysis of 33,600 cases observed at the Hospital for Ruptured and Crippled (1890–1897) shows the following ratios: Inguinal, male to female, 6 : 1 ; femoral, male to female, 1 : 2.14; umbilical, male to female, 1 : 1.6.

[2] Of 22,751 cases of inguinal hernia at the Hospital for Ruptured and Crippled, 5554, or 25 per cent., were in children under the age of fourteen years; while of 1381 cases of femoral hernia, only 18 occurred under the age of fourteen years.

per cent. of herniæ occur before the age of thirty-five, and 60 per cent. after that age. Excepting the period of infancy, when the development of the hernia is due largely to congenital defects, the great proportion of herniæ occur during the period of greatest physical activity—viz., between the ages of fifteen and fifty years.

Elongation of the Mesentery.—This has probably been given too important a place in the etiology of hernia. It has been proved that the normal mesentery is quite long enough to permit the bowel to pass beyond the inguinal or femoral canal; hence, any abnormal increase in the length of the mesentery could only play a secondary part in the development of a hernia.

Occupation.—Hernia is more frequent in persons engaged in occupations requiring severe muscular effort. Among other predisposing causes may be mentioned parturition, which is an important factor in the production of umbilical hernia. Traumatism of the abdominal walls followed by cicatricial tissue is not infrequently a predisposing cause in ventral hernia.

Determining Causes.—The most important of these is sudden strain. A large proportion of herniæ occurring in adult life may be traced to a sudden and severe strain. The hernia does not appear at once as a complete rupture, but usually as a slight fulness only, which gradually increases until at length the patient is able to detect a distinct tumor. Contusion, obesity, ascites, and senile atrophy of muscular tissue, rapid loss of flesh, may all play a part in producing hernia. Some authorities deny that hernia ever follows direct violence. Such a result is rare, but several instances have been observed by the writers. According to Macready, "the principal cause of hernia rests in some imperfection of the structures in the vicinity of the hernial orifice." There is a tendency, especially in adults, for a single inguinal hernia to become double. Macready estimates this tendency at 36.6 per cent. in males and 23.3 per cent. in females.

CLINICAL VARIETIES OF HERNIA.

(*a*) Reducible; (*b*) Irreducible; (*c*) Inflamed; (*d*) Adherent; (*e*) Strangulated.

Reducible Hernia.—This is the most common of all the varieties of hernia. It includes all herniæ in which the contents, of whatever nature they may be, can be replaced in the abdominal cavity. In the majority of these cases posture alone is sufficient to cause the contents to disappear into the abdomen, while in some instances reduction can only be accomplished by taxis.

General Symptoms.—The first symptom, and the one most generally present, is pain. This varies much in character. It is usually dull and dragging. Pain is present in 90 per cent. of cases. If the congenital sac is present, the hernia may enter it with little or no pain. Following the pain, at an interval of a few weeks or months, a fulness is noticed in the groin. This is apt to be more marked on straining or on coughing, and soon an appreciable tumor can be felt, especially if the patient be standing. This tumor disappears on lying down or under light pressure. In addition to pain, there is often a feel-

ing of weakness and discomfort in the region of the groin, especially marked after prolonged exertion. After the hernia has reached the scrotum or has attained considerable size, gastric or intestinal symptoms, probably of reflex origin, may occur.

The sac in congenital hernia is never reducible, and in acquired hernia only in the very early stages, since it quickly becomes adherent to the surrounding tissues.

Physical Signs.—These depend largely upon the size of the hernia and the contents of the sac. If the hernia has not gone beyond the external ring, there will be merely a fulness in the canal, disappearing on lying down and again becoming prominent on coughing or standing, with a distinct impulse on coughing. In scrotal or labial hernia the character of the tumor varies according to whether bowel or omentum is in the sac. If bowel alone, the tumor is smooth and elastic, tympanitic on percussion, and disappears with a "gurgling" sound under pressure.

If omentum alone is present, the tumor is slightly irregular in outline and feels not unlike a fatty tumor. It is always dull on percussion, and the resiliency so characteristic of an enterocele is absent. Impulse on coughing is much less marked, and in many cases can hardly be detected.

Reduction of a Hernia.—This is accomplished by taxis, which will be described more at length under " Strangulated Hernia." The patient should first be placed upon his back, with the legs extended. It is a good rule to begin by drawing down the tumor before attempting to reduce it. The neck of the sac should be pressed upon and steadied by the thumb and fingers of the left hand, and then pressure applied with the right hand, which grasps the fundus of the tumor. The ease or difficulty with which reduction is accomplished depends chiefly upon the length of time the rupture has been down, as well as upon the size of the canal. Flexion of the thigh and other postures so often recommended are of little value in inguinal hernia, though they may be of some slight service in the femoral variety.

Treatment of Reducible Hernia.—There are two methods of treatment: the mechanical and the operative. By *mechanical treatment* is meant the attempt to control the rupture by means of some form of truss. It is necessary to consider but two or three forms, as these embody the essential principles upon which successful mechanical treatment depends. A good truss should so fit the pelvis as to exert an even pressure on all parts, and it should retain its proper place in every position of the body. For inguinal hernia the pad should be so adjusted that it rests upon the internal ring and not upon the pubic bone.

The two forms that best answer these requirements we believe to be the "cross-body" or Knight truss (Figs. 242, 243), used almost exclusively for many years at the Hospital for Ruptured and Crippled, and the Hood truss. The Knight truss consists of a spring of well-tempered steel extending from the internal ring of the ruptured side across the abdomen, encircling the pelvis on the opposite side, and ending posteriorly at a point on a line with the starting-point. The spring should measure three-fourths of the circumference of the pelvis. The remainder of the circumference is completed by means of a leather strap. A short steel shank, 2 inches long, is placed at right angles to the end of the truss, and to this the pad is attached.

The Hood truss, often called the frame-truss, has been modified in various ways. The Pomeroy truss (Fig. 244) is one of the best of this type of truss.
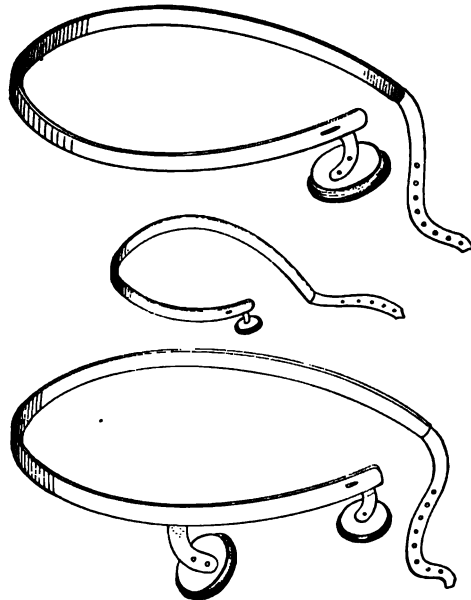
FIG. 242.—The Knight truss, single and double.
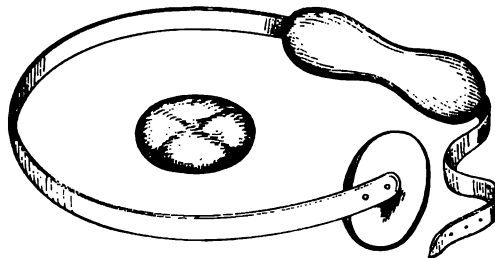
FIG. 243.—" Opposite side " or " cross-body " truss, with pad on end for inguinal hernia.

In addition to these two forms of trusses, which in the majority of cases will be found satisfactory for both inguinal and femoral hernia, reference should be made to the " same
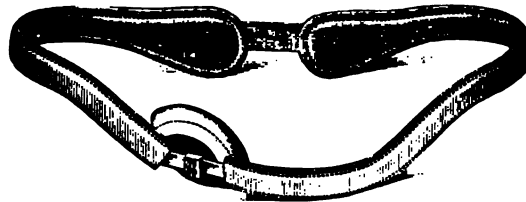
FIG. 244.—The Pomeroy truss.

side " or French truss. In certain cases of femoral hernia, also in inguinal hernia in thin subjects, this form of truss will prove more satisfactory than any other. It may be reinforced by a perineal strap when necessary.

The Application of a Truss.—The proper fitting of a truss requires considerable experience as well as a certain amount of mechanical knowledge. If the matter is left entirely to the instrument-maker, it not infrequently happens that a well-fitting truss is applied to some condition other than a rupture—*e. g.* adenitis, varicocele, hydrocele of the cord, or hydrocele of the canal of Nuck.

The best material for a truss is a light, well-tempered steel spring. The pressure can be most delicately adjusted to suit the varying conditions; it is durable, and if properly covered with leather or rubber (hard or soft), it can be made quite as comfortable as any of the elastic or other trusses of non-metallic material, which are far inferior to the steel truss.

Pads.—These may vary greatly, but in the majority of cases the smooth polished pad of wood or hard rubber gives the most satisfaction. It seldom irritates the skin, and it is even more comfortable than the "soft" pads. A pad made of wood and covered with leather is excellent, and usually very comfortable.

In large herniæ and in herniæ difficult to control the "water" pad will often prove effective where hard pads have failed. The pad should be no larger than sufficient completely to control the hernia. The tendency is to use too large pads; a pad 1½ inches in diameter is large enough for the majority of cases.

The truss should be applied with the patient lying down, except in small and easily reducible herniæ. In the latter the truss can be fitted quite as well with the patient standing.

In adults the truss should usually be left off at night and applied before rising in the morning. In infants and children the truss should be worn constantly, day and night, for the reason that in this class of cases there is ground to hope for a permanent cure; hence the necessity of avoiding any chance of reopening a partially closed sac and canal.

Position of the Pad.—In inguinal hernia the pad should rest as nearly as possible over the internal ring—never upon the pubic bone. The supposed danger from the pad resting upon the pubic bone—viz. pressure upon the cord and atrophy of the testis—has been much exaggerated. The steel band should encircle the pelvis on a level with the upper border of the sacrum behind, and just below the crest of the ilium on the sides. The worsted truss has been much used in children, but the experience of the writers confirms the opinion of Macready, that it is inferior to a well-fitting spring truss.

Mechanical Treatment of Umbilical Hernia.—Nearly all forms of belts and pads are of little value in young children, as it is almost impossible to keep them in place. Treves advocates the application of a single narrow, transverse strip of India-rubber strapping, which tends to draw the skin together and approximates the margins of the hernial opening. This method will answer well for those cases in which the hernial orifice is very small. In general a satisfactory method consists in the application of a strip of rubber plaster about 2 inches in width, in such a way as to encircle the body on a level with the umbilicus; a small pad, consisting of a wooden button covered with plaster or linen, is placed directly over the hernia, so that when the

plaster is in position the hernia will be held perfectly reduced. This cannot get out of place, and the plaster seldom produces much irritation. Great care should be exercised not to have the plaster too tight. It should be changed as often as once in a week or ten days. Cases treated in this way are usually cured within a year, and some in much less time.

In umbilical hernia in adults the best results that we can hope for by means of mechanical support is to control the hernia so well that it does not increase in size nor become adherent. These herniæ when left to themselves almost invariably become adherent and irreducible, and attain great size. When this condition has been reached, it is almost impossible to give more than partial relief.

Various kinds of trusses have been advocated for this form of hernia; but personally we have found an abdominal belt the most satisfactory. The belt should be made of firm material and should be carefully fitted. Most cases require in addition to such belt a pad, usually a flat, circular pad, corresponding in thickness to the fatty layer of the abdominal wall.

Results of Mechanical Treatment.—The great majority of all cures are in infants under the age of one year. The opinion so often expressed, that all children are cured by mechanical means, is not supported by facts. Of 15,000 adult hernia cases observed at the Hospital for Ruptured and Crippled, 700 developed the hernia during infancy or childhood. This would at first sight seem to be a small proportion; but when we consider how large a number of ruptured infants die from various causes before attaining adult life, it may be fairly stated that at least a third of the cases of hernia in infancy and childhood fail to be cured by trusses. This is a very important fact to be remembered in considering the advisability of operating upon hernia in children. The prospect of a cure is somewhat greater in girls than in boys, though this relation is reversed in adults; cure may occur occasionally between the ages of twenty and thirty years, but very seldom in persons older.

Femoral Hernia.—While there is a possibility of a cure being effected by a truss in femoral hernia, this occurs so rarely that it may be fairly disregarded, and this variety of hernia must be looked upon as incurable by mechanical means. All that can be reasonably expected of a truss is sufficient control of the rupture to prevent it becoming adherent and irreducible.

Umbilical Hernia.—Spontaneous cure is the rule in infantile umbilical hernia, and few cases persist beyond the age of fourteen years; hence operation is almost never indicated.

Irreducible Hernia.—This term is applied to a hernia in which the contents of the sac cannot be returned to the abdomen, but in which the circulation and function of the imprisoned omentum or bowel remain unimpaired. This condition is most likely to occur in umbilical hernia, and is more common, in proportion to the number of cases, in femoral than in inguinal, yet it may occur in any variety of hernia. Out of a total of 377 cases collected by Macready, 187 were inguinal and 190 femoral. It is seldom seen in children, occurring in only 3.7 per cent. of inguinal hernia in males under ten years. In children the cecum not infrequently forms the contents of the sac. Irreducible hernia occurs most frequently

in middle life, between the ages of thirty and sixty years. The contents are most likely to be omentum (90 per cent. in 286 cases, according to Macready). Serous fluid in varying amounts is found in the sac in about 13 per cent. in inguinal and 5 per cent. in femoral hernia. The irreducibility may be either permanent or transitory. According to Macready, the condition seldom, if ever, lasts a whole lifetime, and many ruptures that have been irreducible for years may become reducible.

Symptoms.—In some cases there are no symptoms worthy of note, and this is especially true if the rupture is small and is a simple epiplocele. If the bowel forms a portion of the contents of the sac, symptoms more or less severe in character are seldom wanting. Pain, at times dull, "dragging," at times colicky; flatulence; digestive disturbances; irregularity of the bowels, and more or less obstinate constipation, are the symptoms most likely to be present. Attacks of local peritonitis varying in severity are not uncommon. The condition is attended with considerable risk, since it may result in serious inflammation and even in strangulation.

Treatment.—If the condition be of short duration, rest in bed will often cause the hernia to return to the abdomen. If symptoms of local inflammation be present, the application of ice should be added to enforced rest in bed. Strict dieting will often prove of service in very stout subjects. If the hernia be femoral and not very large, reduction may often be accomplished by applying a soft pad made of absorbent gauze over the tumor, and holding this in place by a firm spica bandage. This should be replaced every few days, and can be worn for weeks with little discomfort. Taxis should be used whenever the bandage is changed. It is difficult to estimate the proportion of successes that follow this line of treatment, inasmuch as few patients are willing to submit to the inconvenience.

In *inguinal hernia*, Macready recommends a so-called "hinged-cup truss," which he considers of great value. He states that 68.7 per cent. of irreducible inguinal hernia can be reduced by this truss if worn day and night, the average time required being about fifty days. This truss consists of two parts : one resembling an ordinary pad and occupying the inguinal canal ; the other, or scrotal, part being a triangular frame of metal covered with leather, and curved so as to adopt itself to the distended scrotum. The apex of this triangle is in the direction of the perineum, and to this are attached the perineal straps.

While this or some similar apparatus may be of great service in cases in which operative treatment is contra-indicated, we believe that the majority of cases of irreducible inguinal hernia in persons not too old nor too corpulent had better be subjected to operation. Even if reduced by the devices mentioned, they are unusually difficult to retain, and are liable at any moment to become irreducible again. The same is true of *femoral hernia*. In very large herniæ in which the contents are entero-epiplocele, operation must be considered as attended with no small risk, and should seldom be advised unless the danger from incarceration would seem to outweigh the risk of operation. We have seen numerous recurrences following operation in such cases, and know of not a few deaths. These cases would likewise probably derive little benefit from the "hinged-cup truss." The apparatus that we have found to give the most relief in such cases has been a stout scrotal bag made of canvas

or other strong material, fastened about the pelvis and supported from the shoulders.

Obstructed Hernia.—An irreducible hernia (enterocele) may become an obstructed or incarcerated hernia whenever the passage of feces is interrupted without disturbance in the circulation of the bowel. This condition is most often seen in umbilical and inguinal herniæ of large size in elderly subjects, and the contents are usually made up of some part of the large intestine. The causes that give rise to it are indiscretions in diet, improper mastication of food, and neglected constipation. The fecal matter accumulates in the constricted loop of bowel until a blocking up, more or less complete, occurs.

Symptoms.—These are mild at first and develop gradually, in contradistinction to the symptoms of strangulation. In addition to constipation, symptoms of indigestion appear. The tongue is coated, there is marked anorexia, and later nausea or even slight vomiting may appear. The patient is somewhat weak, but not prostrated. A dull, dragging feeling of discomfort is at first noticed in the region of the hernial tumor. Later this gives way to actual pain, often acute and colicky in character, and not confined to the hernia, but extending into the abdomen. Physical examination reveals the fact that the tumor is somewhat larger, slightly more tense than usual, and somewhat tender on pressure. The impulse on coughing is usually present, though often indistinct and detected only at the upper portion of the tumor. These symptoms may continue for several days and then gradually subside; or they may increase in severity and finally result in strangulation. Repeated attacks of vomiting and failure to obtain relief from laxatives or enemeta, even in the absence of other symptoms, should make one suspicious of strangulation.

Treatment.—Taxis is unwise. It can do no good and may do much harm. Gentle massage of the hernia, and more especially of the abdomen, may, by increasing peristalsis, aid in overcoming the obstruction, but it should only be employed in the absence of tenderness. Cathartics should never be given at the outset, but may be useful after the obstruction has been partially relieved by high enemata. Rest in bed, with the hips elevated and the hernia supported, should constitute the first step in treatment. External applications, preferably warm, should come next in order. As soon as possible high enemata of castor oil, or olive oil, or ox-gall, followed by a large amount of warm water (1 to 2 quarts), should be given through a rectal tube, and repeated at the end of two or three hours. If effective, and if the tumor be appreciably smaller, calomel in small doses and salines may be given by the mouth. Should the obstruction fail to be relieved by repeated efforts, operation should be performed.

Inflamed Hernia.—This condition may occur in any irreducible hernia, as a result of the following causes: Prolonged taxis, contusion, too much pressure of a truss, enteritis, or obstruction. It is simply a localized peritonitis, and is most often seen in femoral epiploceles, though it is not uncommon in inguinal and umbilical entero-epiploceles. The contents of the sac, as well as the sac itself, shares in the inflammation. A serous exudate is thrown out in considerable quantities. This may subsequently undergo absorption and aid in the formation of still firmer

adhesions.   Resolution is the usual result, especially if omentum alone be in the sac; but occasionally suppuration ensues, and strangulation may follow.

Symptoms.—In addition to the enlargement noted in obstructed hernia, local heat and tenderness are found.   If the exudate be large, the tumor will be tense and semifluctuating.   If no bowel is present, the inflamed omentum feels hard and nodular.   With these physical signs will be found a slight increase in temperature (99° to 100° F.) and increased pulse-rate; also nausea, constipation, and occasionally vomiting.   If the hernia be a simple epiplocele, the symptoms are less severe, and usually subside after a few days.   If the hernia is large and both bowel and omentum are involved, the condition is a serious one, and needs most careful watching lest gangrene occur.

Treatment.—This does not differ essentially from that set forth for obstructed hernia.   Except in old persons, ice may be used instead of warm applications.   Opium may be given to control the pain if severe. No cathartics or laxatives should be administered until the pain and tenderness have subsided.   High enemata may be of good service.

Strangulated Hernia.—A hernia is said to be strangulated when, in addition to its being (1) irreducible and (2) obstructed, there is (3) an interference with the circulation of the blood in the contents of the sac.

This accident is rare in the herniæ of infants, and is most frequent in those of mid-life and old age.   It occurs oftener in old than in recent herniæ, in those of small than those of large volume, and in the femoral with greater frequency than in the inguinal or umbilical regions.   Strangulation may take place in two herniæ simultaneously or at different moments.   The writers have seen a patient recover from the operation for radical cure of one inguinal hernia and die from strangulation of another.   Usually the hernia has been in existence for some time, supported, perfectly or imperfectly, by a truss when strangulation occurs. It also supervenes upon the condition of irreducibility and obstruction in some cases, especially with umbilical and scrotal enteroceles; and in others (quite exceptional) it has been first perceived at the moment of strangulation.   This has happened in femoral and in some congenital forms of inguinal hernia.

Causes.—Unusually severe muscular efforts, especially of the abdominal muscles—such as lifting, coughing, straining at stool (unsupported by truss), and the vomiting attending gastric or intestinal disturbances—are the most frequent exciting causes.   In addition, in irreducible cases strangulation may result from obstruction and inflammation, from the constriction of bands and adhesions within the sac, and from torsion or volvulus of the retained loop of gut.   Pulmonary affections, constipation and diarrhea, phimosis, stricture of the urethra, prostatic hypertrophy, occupations which necessitate lifting and other straining efforts, together with neglect in the management of the truss, certainly predispose the subject to this accident.

Mechanism.—The mechanism of strangulation, evidently a complicated process, is not yet satisfactorily explained.   The various theories which have been advanced are summarized by Berger:[1]

I. Elasticity of the ring (elastic compression, Richter).   II. Compres-

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[1] *Traité de Chir.*, tome vi., p. 592.

sion of the efferent by the distended afferent end of the loop (Lossen). III. Angulation, or sharp curvature of the distal end (Scarpa, Busch). IV. Valvular folding of the mucous membrane (Roux). V. Torsion of the imprisoned loop (de Roubaix). VI. Interposition of the mesentery (Berger), which, in the efforts of the intestine to free itself, is spread out like a fan with its apex toward the ring. VII. Fecal impaction.

None of these explains fully the cause of strangulation. Elastic compression may explain strangulation of a partial enterocele with a narrow hernial orifice, or the sudden appearance and simultaneous strangulation of gut in a congenital sac; but it has no support in many cases in which the hernial orifice is not small enough to cause strangulation. The other theories may explain the obstruction; but except in a case of volvulus, which is rarely seen, they do not cover the fact of interference with the circulation. To account for these double features of strangulation another factor must be found, and that is, inflammation of the imprisoned loop. Venous congestion from obstruction is the first step in the inflammatory process. This is caused first by the mechanical obstacle; it is then added to by the increased abdominal pressure. Then follow greater congestion, thickening of the walls from edema, corresponding increase in volume of the mesentery, and serous exudation about the intestine in the hernial sac. These changes increase the volume of the loop beyond the neck and make reduction difficult or impossible. Paralysis of its muscular coat, with the possibility of angulation or volvulus, obstruction or pressure of one loop on the other, or the volume of the mesentery, prevents the passage of feces —in other words, causes intestinal obstruction. The obstruction augments the conditions already induced by the constriction, and this reacts upon the inflammatory features, both factors leading more or less swiftly but surely to gangrene of the imprisoned gut. In some instances, as in strangulation of part of the wall of the intestine (in femoral hernia), elastic constriction is the primary and sufficient cause; in others, as in strangulation occurring in an inguinal hernia with large ring, the volume of which is suddenly increased, the constriction is supplemented by the phenomena of inflammation.

In a third class of cases, especially when strangulation supervenes on irreducibility, the inflammation from obstruction is the primary cause; it is seconded by the disadvantageous position of the extruded gut, the physiological function and pathological processes of which are materially affected by the narrow part of the sac (its neck), the existence of adhesions, and possibly some torsion of its mesentery.

Pathological Anatomy.—The seat of the most marked pathological changes is in most cases at the neck of the sac. This is not because the neck is an active agent of constriction, but on account of its being the narrowest portion of the sac, and the tissues being densest and most resisting immediately about it. In some instances the lesions may be most marked in the sac, owing to its own constricting effect or that of its covering. Pathological changes observed in the contents are the same whether an entire loop or only part of the wall is strangulated. The first abnormal phenomena are those of venous obstruction. The color of the intestine becomes dark red, blue, or mahogany; the wall is thickened from edema, and its surface loses its transparent, smooth, glistening

appearance and becomes dull. This change in color is followed by exudation into the sac, the fluid being at first clear serum, then bloody

FIG. 245.—Loop of small intestine strangulated in the sac of an inguinal hernia (congenital form) (N. Y. Hospital Museum).

or turbid. There follow later coldness of the surface of the bowel, edema of a whole loop, and, at the neck, a deep circular furrow, at first
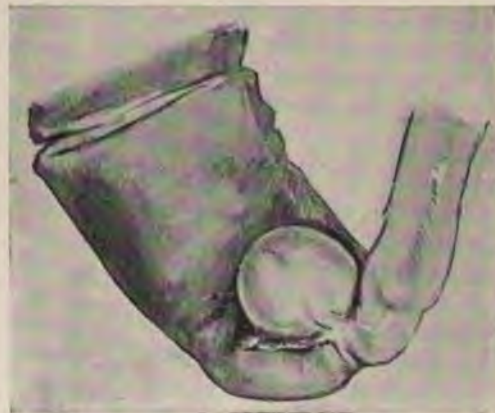
FIG. 246.—Richter's hernia (partial enterocele). A portion of the wall of the small intestine strangulated in the sac of a femoral hernia (N. Y. Hospital Museum).

hemorrhagic, but later gray or yellowish in color. There may be a small area of gangrene leading to perforation, or in the convexity of the

loop there may be one or several such gangrenous spots (an entire gangrenous loop is black or gray in color, without luster, and often granular upon its surface). The whole loop may become gangrenous, and separation of the slough may occur at the neck, the sac being converted into an abscess-cavity, with edema and infiltration of the tissues outside, and discharge of pus and fecal matter externally. There may be the lesions of general suppurative peritonitis before this occurs; or a local and adhesive peritonitis about the neck of the sac may prevent infection of the general peritoneal cavity, so that recovery may ensue through the formation of an artificial anus.

In partial enterocele, or Richter's hernia (Fig. 246), the same changes occur, and may go on to the formation of a fecal fistula or artificial anus, which explains the occasional spontaneous cures observed in these cases, especially in the femoral region. It is rare for gangrene to occur within less than twenty-four hours, though it has been seen after four hours of strangulation. It occurs most rapidly in small herniæ with sudden constriction. The amount of gangrenous gut may be from a few inches to several feet. The omentum in strangulated hernia is not gangrenous or sloughing, but is more or less swollen and softer, and its superficial veins are dilated and sometimes thrombosed. There are numerous adhesions to the sac, and the fluid exudation varies greatly in quantity, some cases being entirely dry. The presence of omentum with intestine in a strangulated hernia delays the progress of gangrene. The sac usually contains fluid which is at first clear, then bloody or turbid with fibrinous masses. Later it is seropurulent in character and foul and ill-smelling. When gangrene occurs, patches of false membrane may be seen on the walls of the sac; with perforation gas and feces are added to the fluid contents. Before perforation occurs, at all stages numerous bacteria, usually the Bacillus coli communis, and several varieties of staphylococcus and streptococcus, are found in the fluid. At an early moment in strangulation the skin and tissues and coverings of the sac are normal in appearance. In case of gangrene the skin is red and the cellular tissue edematous. The abdominal cavity presents the lesions of plastic or suppurative peritonitis, and in some instances there may be intense congestion of the whole intestinal tract, with slight fluid exudation only in the dependent parts of the cavity, but with intense congestion of the kidneys, lungs, and other internal organs—a condition which has been described by some authors as peritoneo-intestinal septicemia. This is found, on careful investigation, to be due to rapid invasion of the abdominal and thoracic viscera by colonies of pathogenic bacteria, with accompanying septic condition of the blood and fatal result before sufficient time has elapsed to bring about more marked changes in the intestinal tract.

Symptoms.—The occurrence of strangulation in a hernia is announced by both local and general symptoms; the latter are those of intestinal obstruction; the former consist in pain, irreducibility of the hernial tumor, tension (especially at the neck), tenderness on pressure, and loss of impulse. In reducible hernia these symptoms are manifested suddenly after unwonted exertion or sudden effort, such as straining at stool when the truss is not in place, violent fit of coughing, in the course of vomiting, and diarrhea of gastro-enteritis. In irreducible

hernia the phenomena of strangulation come on more slowly, and may be preceded by clinical features which are attributable to inflammation or obstruction in the contents of the sac.

Local Symptoms.—When strangulation occurs the hernial tumor becomes irreducible and is exceedingly painful, the pain being located at the neck of the tumor, the umbilicus, and the lower part of the abdomen. The hernial tumor resists every effort at reduction, and is tender on pressure, especially at the neck, where the tissues overlying the hernial sac are felt to be tense. This tension gradually extends to the rest of the tumor, except in a very voluminous hernia. There is no impulse on coughing, and the tumor, if resonant at an early moment, soon gives a dull note on percussion from serous exudation in the sac.

General Symptoms.—The pain is severe, paroxysmal, and accompanied with nausea and vomiting. The vomiting is repeated at more or less frequent intervals, and the vomited matters, which at first consist of stomach-contents, become later more watery, are tinged with bile, and are ill-smelling and in rare cases fecal in character. At a late stage the contents of the small and upper intestine are regurgitated at frequent intervals rather than vomited. Constipation occurs at the outset and persists, no fecal matter or gas being passed. Occasionally the administration of a purgative or an enema is followed by one movement from the bowel below the site of the constriction, and in a few instances diarrhea occurs. The urine is diminished in quantity. At the outset the pulse is increased in frequency, with but slight rise of temperature. Later the pulse-rate is still more increased, but the temperature remains but little elevated, 99° to 100° F. Pain and vomiting persist, and the inability to take nourishment gives rise to increased prostration. Symptoms of general peritonitis ensue if the strangulation be not relieved; the prostration becomes greater, the pulse more rapid and thready in character, the abdomen may be lightly swollen and tympanitic on percussion, and is generally tender; the vomiting becomes more frequent. The surface of the body is cold, and the skin of the extremities cyanotic or dusky, the features are sunken, the expression anxious, hiccough ensues, collapse occurs, and death results. The average duration of life varies from five to seven days.

Course and Variation of Symptoms.—Occasional instances of spontaneous reduction have been recorded, and patients themselves have not infrequently relieved the strangulation by promptly performing taxis; but as a rule strangulation unrelieved leads to death irresistibly, unless the strength of the patient is maintained while the exceptional occurrence of sloughing of the intestine with an artificial anus takes place.

Gangrene or sloughing of the intestine is indicated by redness, edema, and even crepitation (emphysema of the cellular tissue) of the coverings of the hernia. Later there is fluctuation, the fecal abscess is evacuated, and the symptoms improve. With this event there is a chance for recovery—the artificial anus having been known to close spontaneously or to be treated successfully by resection. In epiplocele the vomiting is not so frequent or copious and the constipation may not persist. The local signs are the same, though there may be so-called "dry cases"—*i. e.*, with no fluid effusion in the sac.

In Richter's hernia, or partial enterocele, there may be diarrhea rather than constipation; the vomiting may not be so frequent, but the local symptoms do not vary.

Diagnosis.—The symptoms of intestinal obstruction—pain, vomiting, and constipation—together with the presence of an irreducible tumor at one of the hernial sites, make the diagnosis clear. In fleshy persons and in the rare forms of hernia small hernial protrusions may be overlooked, and one's scrutiny must be close. Between a hernia that is obstructed or inflamed and a strangulated one we may differentiate by the following signs:

Strangulated Hernia.	*Obstructed Hernia.*	*Inflamed Hernia.*
Loss of impulse.	Impulse preserved.	Impulse preserved.
Pain severe.	Pain moderate.	Pain moderate and local.
Tension and tenderness.	Tension and tenderness absent or trifling.	Tender but not tense.
Vomiting.	Vomiting absent or not repeated.	Vomiting not marked.
Constipation.	Constipation relieved by enemata.	Constipation not persisting.

In all doubtful cases it is wiser to act as if strangulation were actually in operation, even to the point of making an exploratory incision, rather than to wait for time to clear up the diagnosis, for successful treatment depends absolutely on the promptness of its application. Conditions which may be difficult to recognize are rupture of intestine in an irreducible hernia and the occurrence of an inflamed appendix in a hernial sac.

In case of septic peritonitis there are, by the third or fourth day, a slight elevation of temperature (101° to 103° F.), and marked tympanitic distention. But more often the peritonitis is marked by trifling abdominal tension, while the general condition generally grows worse —the vomiting and constipation persist, there is rapidity of respiration or small volume and irregular pulse, cyanosis of the surface, and suppuration of urine. Albuminuria and septic pneumonia may cause death (from septic infection) even in cases that have been successfully reduced.

Prognosis.—The briefer the duration of the strangulation the better the outlook after the operation ; in fact, all statistics show that the mortality increases with every hour of strangulation. The prognosis is in general more favorable in young subjects and in herniæ of small volume than in contrary conditions. The most unfavorable conditions are those of voluminous scrotal hernia in which a large amount of intestine has been irreducible for varying periods before becoming strangulated. Here it may be judicious sometimes, after making sure that the neck of the sac is divided and the constriction relieved, to reduce the intestine into the abdomen with its sac—that is to say, with its adhesions to the sac-wall undisturbed. If this be done under these exceptional circumstances, the peritoneum may be closed over a gauze drain of considerable size, which should reach from the intestine to the external air. Such a wound will heal with more or less suppuration, and the result, so far as relapse is concerned, is not likely to be satisfactory.

Complications.—General peritonitis from rupture or sloughing of a returned bowel, and infection of the peritoneal cavity from the contents of the sac, are generally fatal. This is only likely to occur in aggravated cases. Local peritonitis about the wound may persist for a few days, but it gives rise to few symptoms and generally entails no danger.

Intestinal obstruction occasionally occurs from adhesions subsequent to the operation, giving rise to acute kinking or bending of the gut. Shock occasionally causes death in very young and old patients, and in operations undertaken at a late moment. Enteritis and paralysis of the bowel sometimes occur. Neither requires surgical treatment ; but the phenomenon of obstruction should be treated by abdominal section. An occasional cause of death after an operation is inhalation-pneumonia and septic pneumonia, due to the inspiration or sucking into the larynx of fecal contents from the stomach. This accident, which

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sometimes occurs in the course of vomiting during the operation, when the contents of the stomach are fecal in character, is best prevented by washing out the stomach, either before or after the administration of the anesthetic, or, in case the patient does not vomit during the operation, at its conclusion.

An exceptional complication is the escape from the abdominal cavity into the wound of the whole or a portion of the bowel which has been returned. This is more likely to occur if there has been coughing or vomiting after the operation. As soon as the accident is discovered the intestine should be replaced and an iodoform tampon left in the wound.

Mortality after herniotomy is most affected by the duration of the strangulation, being shown by statistics to vary from 10 or 12 per cent. in cases operated upon after strangulation has existed one day or less, to 50 per cent. in cases which had been strangulated over three days. The mortality is naturally greatest in cases which were gangrenous before operation, whether resection or artificial anus be the procedure employed. Furthermore, it is greater in umbilical hernia than in femoral or inguinal, and there are less chances of recovery in infancy and old age.

Strangulation in infants is often less promptly dealt with than in adults because they are subject to attacks of colic and vomiting from other causes, and do not give any clue to the seat of the pain. Repeated vomiting should excite suspicion, and examination should be made of all hernial sites on the naked body. Statistics (Dowd, 100 cases, with 20 deaths) show about the same mortality as in adults, the youngest infant being two months of age. One of the writers has operated upon 7 cases under two years of age, with 1 death. There is every reason for prompt operation and very limited and gentle efforts at taxis. These patients bear operation very well, and the procedure is brief and easy if undertaken in the first twelve or twenty-four hours. We have frequently reduced cases, after a few hours' strangulation, with the aid of applications of hot water and the use of chloroform.

Treatment.—This accident must be treated by a prompt return of the contents of the sac into the abdominal cavity by manual pressure (taxis) or by a surgical operation (herniotomy). Before the employment of either of these measures certain preliminary procedures may be resorted to ; but these should be persisted in for but a few hours. These preliminary measures include rest in bed, absence of nourishment, the administration of morphin subcutaneously, and the application of an ice-bag over the hernial tumor. In children and old persons and those with voluminous herniæ warm applications are preferable. The pelvis should be elevated upon a pillow and the knees should be flexed. While these measures are being carried out, preparations should be made for operation. It may be well to apply taxis without an anesthetic as soon as the patient is seen, if the strangulation is of short duration ; but there is no objection to reserving this procedure until the patient is ready and preparations have been made for an operation. It is desirable, efforts at taxis failing, to proceed at once to an operation.

Taxis.—The position of the patient is important. In all forms of hernia the pelvis should be elevated and the thighs flexed. Inward rotation of the thigh relaxes the tissues in both femoral and inguinal hernia, and thereby favors reduction. Inversion—so termed—of the

patient, the head being placed at a considerably lower level than the pelvis, is of doubtful value and may be attended with accidents. To perform taxis, the neck of the sac should be grasped by the left hand and pressure made over the fundus with the right. The direction of pressure should be according to the nature of the hernia: in scrotal hernia being first upward, then upward and outward, and then backward; in femoral hernia, first directly backward and then upward; in umbilical hernia the pressure is made directly backward. The duration of taxis should not exceed three to five minutes. More prolonged efforts are likely to result in damage to the contents of the sac or to the sac itself, or may facilitate the escape of infected sac-contents into the abdominal cavity. The degree of force exercised should be moderate. In case of a strangulated epiplocele taxis may be a little more prolonged and forcible.

Aspiration of the fluid in the sac has been recommended as an aid to taxis, and Hearn has reported 33 cases aspirated with a hypodermic syringe, after which reduction followed. This is a measure of doubtful value. We have known it to be useful in cases of irreducible hernia.

Successful reduction is followed by disappearance of the hernial tumor, suddenly in case of enterocele, slowly in case of epiplocele. This disappearance should be complete, and should be tested by passing a finger into the inguinal canal, which should be found empty.

Following reduction the pain, vomiting, and other symptoms disappear, and the bowels move spontaneously after a few hours or they respond to an enema.

The after-treatment consists in the use of a pad of gauze or lint, supported by a spica bandage over the hernial orifice. In a hernia of brief strangulation the truss may be replaced. It is best to keep the patient in bed until all symptoms have disappeared and the bowels have moved spontaneously.

Accidents.—Apparent Reduction.—Reduction by taxis is attended by some risks. If it be too forcible or too prolonged, there may be rupture of the bowel or of the sac, or sufficient contusion of the strangulated bowel to invite subsequent peritonitis; there may be a reduction of the sac without relief of the constriction at its neck. This occurs sometimes in femoral hernia. In a properitoneal or inguinal hernia-sac the intestine may be forced from the scrotal to the abdominal portion of the sac. The occurrence of one or the other of these accidents of taxis cannot be distinguished clinically, and may be included under the head of *apparent reduction.* Reduction seems to be successful, but the symptoms of strangulation or of a local peritonitis return after a few hours. This reappearance of symptoms calls for prompt performance of "hernia-laparotomy," which is best done by a vertical incision over the original site of the hernia. Frikhoffer has collected 14.9 per cent. of fatal cases following taxis in 308 cases of femoral, and 7.8 per cent. in 518 of inguinal hernia.

Contra-indications.—Taxis should not be attempted in every case. It is injudicious where a hernia before strangulation has been irreducible, as in many instances of umbilical or scrotal hernia; in case there are symptoms of inflammation, gangrene, or peritonitis. In general,

taxis should not be resorted to after the expiration of twenty-four hours.

Herniotomy.—The operation for the relief of strangulation is termed kelotomy or herniotomy. It should be performed as soon as the brief efforts at taxis have failed, and always, when possible, in the course of the same anesthetic seance. If done promptly, by which we mean within twenty-four hours, or even less, it is likely always to be attended with good result, unless in case of very voluminous herniæ. In view of the success of modern surgical operations it may, when promptly applied, be said to be more successful than taxis injudiciously employed. While a general anesthetic is preferable, it can be performed under local anesthesia, and has succeeded even when patients were extremely prostrated.

Herniotomy, or kelotomy, may be done as follows : *First Step.*—The hernial sac is exposed and opened; the incision, 3 or more inches in length, is made over the neck and upper part of the body of the sac, parallel with the long axis of the hernia. After division of the intervening layers the sac is recognized by the presence of the subperitoneal fat immediately outside of it, by its dark-blue color, and by its gliding over the subjacent hernial contents. In femoral hernia one may encounter a thicker layer of extraperitoneal fat than in any other variety. After recognition of the sac, it should be opened between two artery-forceps, the edges retracted, and the character of the contents noted. The fluid which escapes is clear or bloody, but odorless, if gut be present which is merely congested; this fluid is ill-smelling or seropurulent in the presence of gangrenous intestine. The *second step* consists in division of the constriction at the neck of the sac and return of the contents to the abdominal cavity. In all cases the sac is to be opened and the constriction divided. The return or reduction of the contents depends upon their condition. Division of the constricting neck is accomplished by means of an ordinary bistoury or hernia-knife introduced upon the index finger of the left hand, palm-surface upward, or upon a broad director. A series of nicks rather than a free cut should be made. The contents of the sac are then to be returned into the abdominal cavity by direct pressure, provided they are in good condition; if gangrenous or otherwise damaged, they are left in place or resected. The contents of the sac should be manipulated with the greatest gentleness, and kept warm and clean by frequent irrigation with warm sterilized water. This is the typical and older method of operation. Modern operators have found that as the constriction at the neck of the sac lies chiefly in the tissues external to it, it is advantageous to relieve the constriction by division of these tissues, cutting from without toward the peritoneum rather than from the peritoneum outward, as just mentioned. The latter, or modern, method is unquestionably the better procedure. In femoral hernia the older method still holds good. *Third Step.*—After reduction of the contents of the sac, the wound is sutured with or without iodoform-gauze drainage. When the contents of the sac are found in good condition, the neck of the sac should be ligated, and the tissues overlying it treated as in the method for radical cure.

The intestine is in good condition and fit for return into the abdom-

inal cavity when its peritoneal coat is glistening and smooth; when its color is red, purple, or even mahogany; when it feels firm, elastic, and warm, and when the fluid accompanying it is clear and odorless. It is in bad condition and improper to return it when its serous coat is dull or granular; its color black or gray; when it feels flabby and edematous. In case of doubt, exposure of the intestine in the wound after the constriction has been divided and noting whether its condition improves, will prove of service. In exceptionally dubious cases the intestine may be left in place for from twelve to twenty-four hours, protected by proper antiseptic dressing. Reduction is facilitated by first expressing or squeezing out the air in the retained loop and then reducing the intestine. Small perforations or ulcerations of the intestine require immediate suture after the method of Lembert, with fine sterile silk. A loop of gangrenous intestine must be either resected or left in place in the wound to await the formation of an artificial anus. Under these circumstances a few sutures of catgut may be inserted to hold the intestine in place, although there are usually adhesions sufficient to accomplish this purpose. Intestine left in place should be opened and, by division of the constriction, free escape of intestinal contents—in other words, relief of strangulation—provided for. It is not necessary, as advocated by some surgeons, to remove or resect the gangrenous, suspicious intestine and sew the ends into the wound.

In case the intestine be gangrenous, it may be treated as above described, leaving the parts to form an artificial anus, or a primary resection of the gangrenous gut may be undertaken. In deciding which course to pursue, one must be guided by a consideration of the patient's general condition and the operator's skill or experience in such operations, together with the facilities that are at hand for its performance. If the patient's condition be good, so that prolongation of the operation would be, in the judgment of the operator, unattended with a risk; and if the amount of intestine to be removed be small and the operator experienced in the technic of this operation, it is probably better to resort to resection. It would be better practice, however, in a much prostrated patient, or in one in which several feet of intestine were required to be removed, to leave the parts in condition to form an artificial anus, which could be subsequently cured by a secondary resection. In femoral herniæ, especially in those which consist in a lateral or partial enterocele, an artificial anus or fecal fistula frequently closes spontaneously. Statistics do not afford much satisfaction in determining the course to be pursued in cases of gangrenous hernia. If resection be undertaken, we should give the preference to circular enterorrhaphy or the employment of Murphy's button.

In case the imprisoned intestine be not actually gangrenous, but of doubtful vitality, not sufficiently good, in the judgment of the operator, to be returnable, it is best to divide the constriction and leave the loop for twelve to twenty-four hours external to the abdomen, supported by antiseptic dressing. At the end of this time it may be returned into the abdomen, if its circulation has been thoroughly restored; or small perforations due to ulceration may be closed by suture, or the entire loop resected.

The omentum, which rarely undergoes gangrene, is best treated by

excision if it be much damaged by inflammation. It may be returned if it be normal in appearance. Ligation of the stump of the omentum should be carried out after the method described in the operation for irreducible hernia.

Radical cure of a hernia should be attempted, after relieving the strangulation, in all cases in which the contents are returned to the abdomen and the condition of the patient warrants. This is accomplished with but little additional shock, and its performance in no way differs from the operation as described for reducible hernia. In view, however, of the risks of local sepsis in the wound, it is better, after ligating the sac and suturing the orifice, to leave a small tampon of iodoform in the wound, which may be withdrawn at the end of forty-eight hours.

Accidents are exceptional, but all of the following may be noted: hemorrhage from blood-vessels, from the separation of adhesions; wound or tear of the intestine; wound of the bladder; reduction of the strangulated loop into the upper segment of an hour-glass or pro-peritoneal sac.

ANATOMICAL VARIETIES OF HERNIA.

INGUINAL HERNIA.

This term includes all herniæ emerging through the inguinal canal. These herniæ may be subdivided as follows: 1. Indirect or oblique inguinal hernia; 2. Direct inguinal hernia.

Oblique inguinal hernia may be either congenital or acquired, while the direct variety is always acquired. By congenital inguinal hernia is not, as a rule, meant a hernia existing at birth, but one in which the

FIG. 247.—Left inguinal hernia (incomplete).

sac was preformed, dependent upon some anomaly of congenital origin. Such herniæ not infrequently are first noticed long after birth, and

sometimes in adult life. An acquired hernia is one in which the sac has been developed from the parietal peritoneum, which has been

FIG. 248.—Left inguinal hernia (scrotal).

gradually pushed forward and stretched as the hernia advanced. An *oblique inguinal* hernia is distinguished from the *direct* variety by the

FIG. 249.—Inguinal hernia in the female.

relations that each bears to the epigastric artery. In oblique hernia the neck of the sac is external to the deep epigastric artery, and the

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sac itself crosses the artery nearly at right angles on its way to the external ring. In direct hernia the protrusion emerges not at the internal ring as in the oblique, but through a new opening below and to the inner side of the epigastric vessels, and does not cross them at all. A direct hernia is really a ventral hernia. In hernia of long standing it may not always be possible to make out this anatomical distinction, but in most cases the position, and especially the shape, of the tumor will render the diagnosis easy.

Oblique Inguinal Hernia.—This is by far the more common variety, 93 per cent. of all inguinal herniæ being oblique. As already stated, it may be congenital or acquired. Most writers have classed under congenital hernia cases in which the hernia has entered an unobliterated funicular portion of the tunica vaginalis; but as it is difficult to distinguish anatomically such cases from acquired herniæ, we believe it better to apply the term " congenital " only to those cases in which the contents of the sac are in contact with the testis. Congenital hernia may occur in the female, the sac being preformed and made up of an unobliterated " canal of Nuck." No accurate estimate can be made of the relative proportion of congenital and acquired herniæ, for the reason that the diagnosis cannot be made without operation. The statements found in the older text-books to the effect that all herniæ in children were congenital, and all herniæ in adults acquired, can no longer be accepted as true.

A study of upward of 500 cases of hernia in children under the age of fourteen years, operated upon by the writers, shows that in more than one-half of the cases the sac did not communicate with the tunica vaginalis. Whether the hernia was wholly acquired or partially preformed, due to a funicular process of peritoneum remaining unobliterated, cannot be stated positively.

Anatomical Relations.—In both the acquired and the congenital forms of oblique inguinal hernia the anatomical relations are the same. The sac emerges from the abdomen through the internal ring above and a little outside of the deep epigastric artery; it passes obliquely downward parallel with Poupart's ligament, crosses nearly at a right angle the deep epigastric vessels, and protrudes at the external ring. In the early stages of oblique inguinal hernia the hernia does not pass beyond the external ring, and this form of hernia is frequently known as *bubonocele*. If the hernia continues to enlarge, it soon passes beyond the external ring and enters the scrotum; it is then known as a *complete*, or *scrotal*, hernia.[1] The entire length of the inguinal canal in the adult is about 2 inches, and it is slightly larger in the male than in the female. There is also much greater tendency for an oblique hernia in the male to become a scrotal hernia, than for one in the female to become a labial hernia. The anatomy of oblique inguinal hernia may be briefly stated as follows: Beginning at the internal ring, situated about half-way between the anterior superior spine and the symphysis pubis, about ½ inch above Poupart's ligament, we have the hernial sac passing outward and downward in the way already described. This sac rests upon a floor made up of the transversalis fascia and the per-

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[1] In very rare cases the sac may enter the perineum instead of the scrotum. One of the writers has operated upon 4 such cases.

itoneum, between which layers run the deep epigastric vessels. The roof of the canal is made up of the internal and external oblique muscles, the aponeurosis of the external oblique, the superficial fascia, and the subcutaneous tissue and skin. The external ring is formed by the arched fibers of the aponeurosis and external oblique, and varies in size according to the size of the hernia. In the normal canal the external ring barely admits the tip of the index finger, and the internal ring cannot be palpated at all from the outside. In a large hernia of long standing the canal becomes so dilated as almost entirely to lose its original obliquity, so that it becomes difficult to distinguish a direct from an indirect hernia except by operation.

The Relation of the Sac to the Cord.—As the sac passes down the canal and out of the external ring it always occupies a certain definite relation to the cord: It lies directly in front of and in intimate contact with the cord, the two being enveloped in a common layer of fascia, called the infundibuliform fascia. It has been claimed by some recent writers [1] that this intimate relationship only exists in the case of congenital herniæ; but our experience has proved that it is true for the acquired as well as for the congenital variety. In direct hernia this intimate relation does not exist, and the cord is quite independent of the sac. It is a very common error to suppose that under certain conditions the cord may be found inside of the sac. This, of course, is impossible when we remember the early development of the testis and cord. At no period during the development is the testis inside of the peritoneal cavity. Hence it is impossible for the cord ever to be found inside of a hernial sac.

FIG. 250.—Labial hernia (M. H. Richardson's case).

As to the shape of the oblique hernia, this depends entirely upon whether it has advanced only to the external ring or has reached the scrotum. The shape of a bubonocele is that of an elliptical swelling

[1] John H. Packard, *Trans. Amer. Surg. Assoc.*, 1896.

over the inguinal canal, which is seldom pronounced except on standing or coughing.

The shape of a scrotal hernia varies with its size. In a small hernia it is usually cylindrical; the larger herniæ are pear-shaped, the lower portion being the larger. In very large herniæ the penis may be entirely obliterated.

Oblique Hernia in Women.—As we have stated, inguinal hernia in the female is generally confined to the canal, only about 4 per cent. becoming labial (Fig. 250). It seldom becomes irreducible, and is more easily controlled by truss than in the male. This variety of hernia is the most favorable of all for operative treatment. One of the writers has operated upon 100 cases without any relapses.
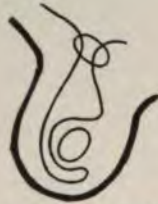
There is a rare form of hernia, usually termed *infantile* or *encysted hernia*. This variety is always acquired, and a knowledge of its anatomy is important. It is best explained by the accompanying diagrams (Figs. 251, 252). Its development is briefly described as follows: As the testicle descends into the scrotum the funicular process of peritoneum accompanying it becomes closed at its upper portion, but remains patent below. If under these conditions an acquired hernia develops, the sac is pushed forward until it meets this unobliterated part of peritoneum, and thus two sacs are formed, one within the other.

FIG. 251.—Congenital hernia.

Diagnosis of Oblique Inguinal Hernia.—When the hernia occupies the inguinal canal only, it is termed a bubonocele, or incomplete inguinal hernia. The chief diagnostic signs during this period are a tumor in

FIG. 252.—Different varieties of infantile hernia: *t*, testis; *s*, sac; *f*, funicular portion of tunica vaginalis.

the region of the inguinal canal and impulse on coughing. The only symptoms worthy of note are a feeling of discomfort and slight pain, tumor, and impulse on coughing. The pain may be either acute or dull, and is usually confined to the site of the hernia, though in some

cases it is located in the region of the umbilicus. Pain may be severe and sharp in the early stage of the hernia, and gradually give way to a sense of discomfort. According to Macready, pain occurs in 96 per cent. of all cases.

Tumor is noticed next in order of time, and appears first at the internal ring; the tumor in the beginning is nothing more than a slight bulging, which becomes larger on coughing or lifting, and disappears entirely on lying down.

Impulse on Coughing.—This is a very constant and valuable sign in reducible hernia. It cannot be made use of in young children, but crying affords an excellent substitute for coughing.

The other conditions in the groin which may be mistaken for an incomplete inguinal hernia are the following: Femoral hernia; hydrocele of the cord in the male; hydrocele of the canal of Nuck, or cysts of the round ligament in the female; psoas abscess; inguinal adenitis; retroperitoneal adenitis; tuberculosis of the cord; malignant disease of the glands; fatty tumors; and tuberculosis of the os pubis.

Femoral Hernia.—In ordinary cases it is not difficult to make the diagnosis between inguinal and femoral hernia, if we bear in mind the two principal landmarks—namely, the spine of the pubic bone and Poupart's ligament. In the male the diagnosis is less difficult than in the female. The external ring can always be made out and the spine of the pubis located by pushing the index finger into the canal, following the external pillar of the ring to its point of insertion, which is the pubic spine. In the female the diagnosis is more difficult and sometimes impossible, especially in fleshy subjects. If Poupart's ligament cannot be felt, we may substitute for it a line drawn from the anterior superior spine of the ilium to the spine of the pubis; if the hernia is above this line, it is an inguinal, if below, a femoral hernia.

Hydrocele of the Cord.—The diagnosis can be usually made from the peculiar cyst-like character of the swelling, which is more freely movable and more tense than in an inguinal hernia, except in a case of strangulation.

Hydrocele of the Canal of Nuck or of the Round Ligament.—The clinical features of this swelling correspond very closely to those of hydrocele of the cord, already described. It is a much rarer condition than hydrocele of the cord, and for this reason is usually mistaken for a hernia. A correct diagnosis ought to be possible in nearly every case, if the following points are carefully observed: A globular tumor, situated distinctly in the inguinal canal or easily pushed into the canal; freely movable; not reducible, or rarely so; no impulse on coughing; and a peculiar elastic sensation on pressure. These physical signs added to a history of having originated without apparent cause, having existed for a considerable time, of slow increase in size without giving rise to any constitutional symptoms, make the diagnosis of hydrocele of the canal of Nuck or of the round ligaments reasonably certain. The diagnosis can be easily confirmed, without risk, by means of aspiration with a small hypodermic syringe.

As regards the frequency of hydrocele in the female, 14 cases were observed in the Hospital for Ruptured and Crippled in the years 1890 and 1891; 62 cases were collected

from surgical literature by Wechselmann;[1] in 1892 Coley collected 16 others from literature, which, in addition to the 14 cases observed at the Hospital for Ruptured and Crippled, make a total of 92 cases.

Fatty Tumors.—These are, as a rule, more superficial, softer in consistence, and lobulated. Very careful examination will usually disclose the fact that the tumor does not occupy the exact anatomical situation of a hernia.

Lymphatic Glands.—Enlarged glands of secondary malignant disease are a source of a great number of errors in diagnosis. The position of the swelling is important, especially in inguinal hernia, though the diagnosis must rest, as a rule, upon the character of the swelling itself. In adenitis the tumor will be found more diffuse, and is frequently made up of several small nodules rather than one distinct tumor. The skin is often more or less adherent, and occasionally reddened, a condition seldom found in hernia. In all cases of doubt, an examination of the genitals and the lower extremities should invariably be made for a possible source of infection.

Psoas abscess is not infrequently mistaken for a hernia, and in some cases the diagnosis is attended with much difficulty. The swelling may be exactly in the situation of a hernia, may disappear on lying down, and may even have a distinct impulse on coughing, in which case the only method of differentiating it from a hernia is by manual palpation. The patient should be examined when lying on his back; one hand should be placed deeply into the pelvis above the tumor, and firm pressure made upon the tumor itself with the other hand. If a hernia, the tumor, disappearing in the inguinal canal, will not be felt by the hand in the pelvis; while, if psoas abscess, the tumor will be distinctly felt in the pelvis, and the presence of fluctuation will be determined, which will render the diagnosis easy. In case of a suspected psoas abscess, most careful examination should be made of the spine and pelvis for evidence of bone disease.

Undescended Testis.—A retained testis in the inguinal canal may cause nearly all the symptoms of a hernia. In every patient examined for a possible hernia the scrotum should be first inspected for the purpose of ascertaining whether or not both testes have descended. If the testis has never reached the scrotum on the side in question, and the tumor in the inguinal canal is about the size of a normal testis or somewhat smaller, resembling it in shape, consistence, and, above all, if it gives the characteristic sensation on pressure, the diagnosis is reasonably certain. In very many cases there is a small rupture in addition to the undescended testis.

Diagnosis of Scrotal or Complete Inguinal Hernia.—The conditions most likely to be mistaken for this variety of hernia are the following: Hydrocele, hematocele, varicocele, tumors of the testis, edema of the scrotum, ascites with patent process of peritoneum.

Hydrocele.—This is the source of the greatest number of mistakes in diagnosis. The diagnosis is usually made without difficulty by observing the following distinguishing signs: Hydrocele is not reducible except in rare instances, the swelling occupying the scrotum, but seldom extending into the inguinal canal. There is translucency, which

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[1] *Arch. f. klin. Chir.*, Band xl., S. 579.

can almost always be made out except with a greatly thickened tunica vaginalis, and a peculiar cystic character of the swelling, entirely different from that of a hernial tumor. The history is also of importance. In hernia the swelling is first noticed in the groin; whereas in a hydrocele enlargement appears first in the region of the testicle and gradually rises higher. In reducible hydrocele the diagnosis is not so easy; the swelling disappears on lying down, reappears on standing, and has even a slight impulse on coughing; but the character of the impulse, giving the peculiar sensation of fluid passing through the canal, is the chief feature which differentiates it from a hernia. If the swelling be reduced and light pressure applied over the inguinal canal, the patient being allowed to stand, the swelling in the scrotum will slowly reappear if it is a reducible hydrocele.

Hematocele.—This seldom gives rise to difficulty in diagnosis; the history will usually be all that is required.

Inflamed Testis.—This, next to hydrocele, is the source of the greatest number of errors in diagnosis. Out of 824 cases of mistakes in diagnosis at the London Truss Society, this was the cause in 107 cases. The character of the swelling and the history of the case, together with a correct knowledge of the important physical signs of hernia, will be all that is required to distinguish between these two conditions.

Varicocele.—This condition is not infrequently mistaken for a hernia. In most cases the diagnosis is easy, though in a few it is extremely difficult. The tumor may have all the characteristics of an omental hernia; it may disappear on lying down, reappear on standing, and may give a distinct impulse on coughing. The point which serves to distinguish it from a hernia is the peculiar character of the impulse on coughing; this impulse is caused by the forcing of the blood through the enlarged veins, and differs much from the impulse caused by a piece of omentum or bowel; it gives the peculiar sensation of fluid passing through the canal, already referred to in the reducible hydrocele. The same sensation is also met with, on coughing, in saphenous varix.

Diagnosis of Contents.—It is seldom possible to make a diagnosis of the contents of the sac, except to say that bowel or omentum—one or both—are present. In a few cases, especially in children, the appendix can be easily palpated in the hernial sac; several cases of this kind have been observed at the Hospital for Ruptured and Crippled, in which the diagnosis was afterward confirmed by operation.

Diagnosis of Adherent Omentum.—This condition is usually easily made out; yet changes may take place in the omentum, especially if irreducible, that may obscure the diagnosis. As a result of chronic inflammation, the omentum frequently becomes hard and lobulated, so that it closely simulates an enlarged gland. A certain amount of effusion may take place in the hernial sac, when, adhesions having formed at the neck of the sac, the fluid may accumulate about the enclosed omentum so as closely to resemble a hydrocele of the cord.

Tuberculosis of the cord and *malignant degeneration of omentum* have been mistaken for inguinal hernia. These conditions are so rare, however, that they need only be mentioned.

Direct Inguinal Hernia.—This variety is always acquired, and rarely, if ever, occurs in children. It is far more common in men than in women; compared with indirect or oblique hernia, it is rare, and is said to occur in about the proportion of 1 : 17. Strictly speaking, it is a ventral hernia rather than an inguinal one, since it does not pass through the inguinal canal, but is forced through the conjoined tendon, very nearly at a level with the external ring.

The **relation of the sac to the cord** is very different from that in oblique hernia. In oblique hernia the sac is always found anterior to the cord, and is enclosed in a layer of fascia; while in direct hernia the cord is usually directly anterior to the sac, though occasionally it may be found to one side, and the two are not enclosed in a common layer of fascia. Another important landmark is the relation of the sac to the epigastric vessels. In direct hernia the sac emerges below and to the inner side of the epigastric artery, while in the oblique variety it passes

FIG. 253.—Right direct inguinal hernia with left hydrocele.

FIG. 254.—Double direct inguinal hernia.

out of the abdomen above and to the outer side. These relations are of great importance in operations for the radical cure of hernia.

Coverings of the sac in a direct hernia, with exception of the cremasteric fascia, are practically the same as those in the oblique.

The **shape of the tumor** is the most characteristic feature of a direct hernia; it is almost always globular, and as it increases in size it projects directly forward, and rarely extends into the scrotum.

FEMORAL HERNIA.

Femoral, or crural, hernia may be defined as a protrusion through the crural canal. According to the statistics of the Hospital for Ruptured and Crippled, the proportion of femoral to inguinal hernia is about 1 : 17, although Macready gives a slightly higher ratio. This variety is always acquired, and is seldom met with before maturity. It may occasionally, however, occur in children. One of the writers has operated upon 14 cases under the age of fourteen years, 1 of these being a double femoral hernia in a male child aged two years.

Anatomy.—The most important anatomical landmarks are the following: Poupart's ligament, the pubic spine, and the femoral vessels. The formation of a femoral hernia may be briefly described as follows:

FIG. 255.—Femoral hernia in a child aged seven years.

The parietal peritoneum is at first pushed directly downward in the sheath of the femoral vessels until it reaches the cribriform fascia, which

FIG. 256.—Very large femoral hernia.

it either penetrates or passes beneath. At the lower end of the femoral canal it curves forward, coming out at the saphenous opening, just internal to the femoral vein. Femoral hernia is usually globular and seldom

attains large size, the ordinary type being about as large as a hen's egg. Occasionally it may extend down the thigh for a considerable distance, forming a tumor the size of a child's head. In other cases, advancing in the line of least resistance, it passes upward, overriding Poupart's ligament, and in such cases may closely resemble oblique inguinal hernia. This form has been incorrectly described by some writers as the more common type.

Anatomical Relations.—In a great majority of cases the neck of the sac is situated to the inner side of, and nearly in contact with, the sheath of the femoral vein. In a few cases, however, it lies directly over the femoral vessels; still more rarely it may even be found to the outer side of the artery. A few such cases have been observed at the Hospital for Ruptured and Crippled. On the inner side of the sac is found the spine of the os pubis; beneath it lies the floor of the crural arch, made up of a continuation of the iliac fascia, while above and anteriorly is the falciform process of the fascia lata and Poupart's ligament. The variable position of the obturator artery is a point of much importance, especially when

FIG. 257.—Right femoral hernia.

operating for this form of hernia. In 1 case out of every $3\frac{1}{2}$ the obturator artery arises from a common trunk with the epigastric. According to Treves, in 54 out of 101 cases in which it so arose, it passed to the outer side of the crural ring; in 37 it passed backward across the ring, and in 10 around it and to the inner side. It is only in the position last mentioned, or in 10 per cent. of the cases, that one would be likely to injure the artery in performing herniotomy. Neither of the writers has seen this accident occur, and it is their impression that with the methods now employed in operations for strangulated hernia, in which the tissues are freely exposed, the risk from cutting the artery is very slight, and, if cut, the hemorrhage ought to be easily recognized and controlled.

Coverings of the Sac.—1. The subcutaneous tissue; 2. Fascia propria of Cooper, made up of the septum crurale, femoral sheath, and cribriform fascia; 3. The subperitoneal fat and the peritoneum.

Contents of the Sac.—The contents of the sac are practically the same as in inguinal hernia, though the intestine is far less frequently found. In femoral herniæ of small size the contents almost always consist of omentum alone, which, unless perfectly controlled by a truss, early becomes adherent.

Clinical Features.—In the majority of cases very few symptoms attend the early development of femoral hernia. Slight *pain* or a sense of discomfort is the most common symptom. The progress is usually very gradual, and in many cases the first thing observed is a lump in the groin. This swelling may be so small as to be nearly overlooked, but still large enough to contain a loop of intestine that may become strangulated without previous history of a hernia. Hence the great importance of carefully examining the femoral canal in all cases of acute intestinal obstruction. Owing to the sharp edge of the falciform process, femoral herniæ are much more difficult to reduce, and also more liable to become strangulated. Furthermore, when strangulation has occurred, gangrene follows more quickly than in the inguinal variety.

Diagnosis.—The chief points in the diagnosis have already been referred to under Inguinal Hernia. The conditions most likely to be confounded with femoral hernia are: Adenitis, psoas abscess, saphenous varix, malignant disease of the glands, lipoma, and hypertrophy of the subperitoneal fat.

Psoas Abscess.—The diagnosis is best made by the method of examination already described for inguinal hernia.

Saphenous Varix.—This is a more common source of error than psoas abscess. The tumor is in exactly the situation for a femoral hernia, which it resembles very closely in shape; moreover, it has a distinct impulse on coughing, and is reducible under pressure or on lying down. The diagnosis is made by carefully observing two points: 1. The character of the impulse, which is more in the nature of a thrill caused by fluid than a pressure of a solid body against the finger. 2. The fact that the tumor slowly reappears on standing, even when moderate pressure is applied to the crural opening. An important aid to the diagnosis will be found by examining the thighs and legs, for the reason that in nearly all cases these will be found in a varicose state, if the condition be one of saphenous varix.

Lipomata may occur in the region of a femoral hernia. If situated exactly over the femoral canal, the diagnosis may be very difficult. We should find a greater mobility in a lipoma than in a hernia.

Hypertrophy of the fatty tissue in the vicinity of the crural opening may very closely resemble a reducible femoral hernia. The history of the case may aid somewhat in the diagnosis, although in some instances it will be impossible to settle it absolutely without operation. It is a point well worth remembering that this hypertrophy of fatty tissue occurs more commonly in the presence of a small hernial sac than alone. In several cases upon which we have operated, a mass the size of a hickory-nut or an English walnut had been felt in the femoral canal, in the exact situation for a femoral hernia, and had been mistaken for an irreducible omentum. Operation proved this mass to be hypertrophied extraperitoneal fat instead of omentum; but in every case it was found associated with and closely adherent to a true hernial sac.

31

UMBILICAL HERNIA.

Three varieties should be mentioned in connection with this form of hernia: 1. Congenital hernia of the cord; 2. Infantile hernia; 3. Adult hernia.
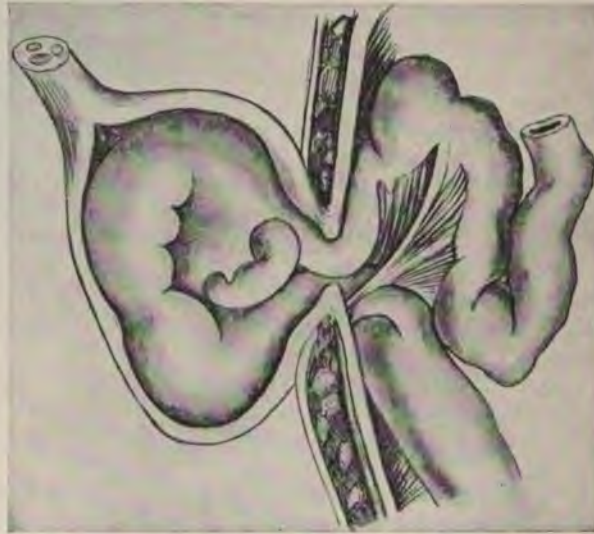
FIG. 258.—Congenital hernia of the umbilical cord (Albert).

Congenital Hernia of the Cord.—This variety is due to a defective closure of the visceral plates in the region of the umbilicus during
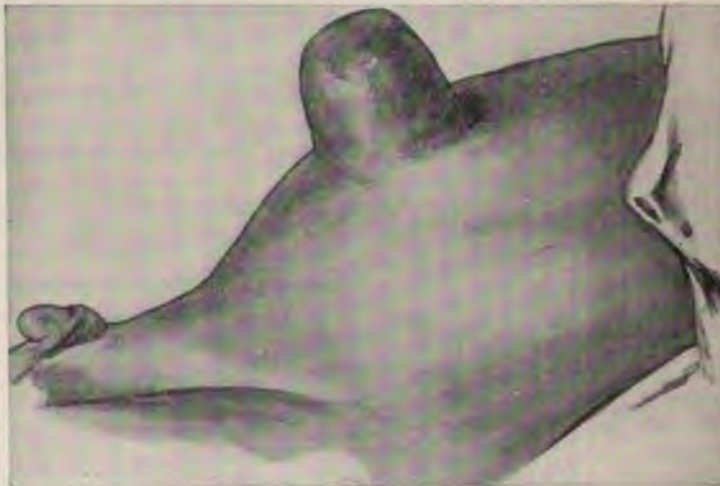
FIG. 259.—Umbilical hernia in a child.

fetal life. As Malgaigne well says, the term hernia is improperly used for this condition, " for it is concerned not with viscera that have escaped

from a cavity, but with viscera that have never entered it." It is always present at birth, but is exceedingly rare. According to Lindfors, it occurs only once in 5184 cases. Two cases were observed in a single week at the Hospital for Ruptured and Crippled in 1899. In 1 case the tumor was the size of the child's head (complete eventration), and in the other the size of a large orange. In the latter case operation was successfully performed. It varies greatly, from a small bulging at the base of the cord to a complete eventration, in which the abdomen is open throughout its entire length. In this case nothing can be done to relieve the condition, and death occurs very promptly. In the milder varieties we have a distinct sac, made up chiefly of the tissues of the cord; the cecum is most often found in the sac in this variety of hernia. The sac is so thin that not infrequently it ruptures soon after birth, in which case peritonitis results. In some instances in which the hernia is very small it may be overlooked when ligating the cord, the result being either death or a fecal fistula. The prognosis is better after operation than after tentative measures. According to the statis-

FIG. 260.—Large umbilical hernia.

tics of McDonald, of 31 cases, 12 were treated by bandage-compression, with 9 deaths; while 19 were operated upon, with 2 deaths.

Infantile Umbilical Hernia.—The great majority of umbilical herniæ come under this head. It occurs equally often in both sexes, especially before the age of puberty, after which time it is more common in the female. Including all cases, Macready estimates the ratio between the male and female cases at 1 : 2.7. In 2795 cases analyzed at the Hospital for Ruptured and Crippled the ratio was 1 : 1.6. It is far more common during the first year of life.

Anatomy.—The anatomy of this form of hernia is very simple, it being a direct hernia protruding through the opening in the linea alba originally occupied by the cord.

The *coverings* are peritoneum and deep fascia, superficial fascia, and skin. This variety of hernia is almost invariably reducible, and strangulation rarely, if ever, occurs. No case has been observed at the Hospital for Ruptured and Crippled. The rupture causes very little incon-

venience, and seldom persists beyond the age of puberty, no matter what form of treatment has been carried out. Macready states that he has seen 1 umbilical hernia, occurring in a man twenty-five years of age, which had existed since infancy.

Umbilical Hernia in Adults.—This variety is always acquired, and seldom occurs before the age of twenty. It is found chiefly in women, and especially in obese women, beyond thirty years of age. It can usually be traced to some strain or overlifting, and not infrequently it follows the pains of childbirth. The sac comes out of the abdomen at the umbilical ring, usually at its upper portion, or the part formerly occupied by the umbilical vein. The coverings of the sac consist of little more than the skin and peritoneum, which frequently become so exceedingly thin as to be in danger of rupture. This accident, fortunately, is not common, yet ulceration and erosion are not infrequent.

Contents of the Sac.—In nearly all cases the sac at first contains omentum, which soon becomes adherent and irreducible. As the sac enlarges, the intestine also may enter, especially the transverse colon. The opening through which the hernial sac protrudes is usually situated at the upper portion of the umbilicus, the site originally occupied by the umbilical vein; hence the latter is nearly always found in front of the sac. We have operated on several cases in which the bowel was completely surrounded with an omental sac in addition to the peritoneal sac.

Symptoms.—These differ little from those seen in an irreducible inguinal hernia. Owing to the large size and the extensive adhesions, they are apt to be more severe and more annoying. Attacks of local peritonitis are common, and are attended with considerable pain and discomfort. Constipation, or constipation alternating with diarrhea, is a very frequent symptom. In some cases the constipation is very obstinate, and it may be attended with considerable pain and tenderness, the pain often closely simulating that occasioned by a strangulated hernia.

The **diagnosis** in such cases may be by no means easy, and the patients require the most careful watching, for this condition may easily pass into one of strangulation.

HERNIA OF THE BLADDER.

Up to the year 1889 about 180 cases had been recorded, which have been carefully studied by Brunner.[1] Of these, 138 were inguinal, 29 femoral, and 14 other varieties of hernia.

A bladder hernia is almost always acquired, and its existence depends upon frequent distention of the bladder, weakness of the bladder-wall with loss of its power of contractility, and weak and unresisting hernial orifices. These causes are directly helped by obstruction to the outflow of urine from strictures, prostatic hypertrophy, tumors of the pelvis, pregnancy, fibroid tumors of the uterus, and accumulation of fat in the prevesical space. It has been met with also in herniæ that relapsed

[1] *Deutsch. Zeit. f. Chir.*, Band xlvii., S. 121.

after a radical operation. It is three times more frequent in men than in women, the average age of the patients being about fifty years. There are three varieties to be distinguished anatomically, according to the relations of the peritoneum to the bladder: I. *Extraperitoneal*, in which the bladder lies wholly without the hernial sac. II. *Paraperitoneal*, in which it lies partly within and partly without the hernial sac; this is the most frequent form. III. *Intraperitoneal*, in which the bladder lies fully within the hernial sac.

As a rule, but a small portion of bladder-wall is involved, although small diverticula on the one hand, and almost the entire bladder on the other, have been encountered. In but a small number of cases has the diagnosis of hernia of the bladder been made before operation. Its most marked symptom is the presence of a hernial tumor, the size of which is changed by the act of micturition. In the course of an operation for radical cure or for strangulation, the presence of an unusual amount of extraperitoneal fat may lead to suspicion that the bladder is situated beneath it, and caution must be exercised to investigate such masses of fat by careful dissection, or by the introduction of a sound or the injection of water before cutting into or removing them. In 13 of the 180 cases the diagnosis was made before the operation. Injuries of the unrecognized bladder have been observed in about one-third of the operations.

Treatment.—Large herniæ which can be made out to contain the bladder cannot be treated successfully by operation because of the weak and relaxed condition of the abdominal wall, although a few successful efforts have been made to accomplish a cure by resection of a portion of the bladder, together with suture of the hernial orifice. They are probably best left to the support of a bag-truss, and the urinary difficulties overcome by the use of a catheter. Small herniæ containing the bladder, whether recognized at the time of operation or before, are best treated by reducing the bladder, together with other contents of the hernial sac, in the course of a radical-cure operation. They are not suitable for treatment by means of a truss.

If the bladder be injured in the performance of herniotomy, its wall should be promptly sutured; the organ should then be replaced in the abdominal cavity, and a catheter left in place for three or four days, with an iodoform tampon leading through the hernial orifice to the site of the wound in the bladder. If no leakage occurs, this tampon may be withdrawn at the end of forty-eight hours and the remaining steps of a radical-cure operation be completed. Some surgeons have preferred frequent catheterization to leaving a catheter in place. Both plans have been followed with good result. If injury to the bladder is recognized only after the operation has been completed (by symptoms of cystitis or urinary infiltration), the wound should be promptly opened and the damaged bladder sutured and treated as just described. Urinary fistulæ which occur subsequent to these procedures generally heal without special treatment.

INTERSTITIAL HERNIA.

This form of hernia receives its name from the peculiar position of the sac with reference to the abdominal parietes.   There are three distinct varieties of interstitial hernia: 1. The sac lies between the transversalis fascia and the parietal peritoneum.   2. The sac lies beneath the aponeurosis of the external oblique muscle.   3. The sac is found beneath the skin and overlying the external oblique muscles.

The *first variety* is comparatively rare, and, owing to the absence of an external tumor, the diagnosis has been seldom made until strangulation occurred.   The term "properitoneal," adopted by Krönlein, is very properly applied to this variety, though it is often used to include all forms of interstitial hernia.   There may be, and often is, in addition to the sac described, another sac entering the scrotum and resembling that of an ordinary hernia.

FIG. 261.—Interstitial hernia: P, peritoneum; T, testis; C, cord; S, sac.

Second and Third Varieties (Interparietal).—This is by far the most common of the three.   Macready states that it occurs in the proportion of 1 : 1000 in cases of inguinal hernia in males.   It occurs twice as often on the right side as on the left, and is five times as common in males as in females.

Etiology.—In a very large proportion (70 per cent.) of cases of

FIG. 262.—Right inguinal properitoneal hernia, with undescended testis.

intraparietal hernia there will be found an undescended or partially descended testis, and this fact has an important bearing upon the devel-

opment of the hernia. The hernia reaching the testis, which is usually found in the canal, and unable to advance further in a downward direction, follows the line of least resistance, and gradually dissects a space between the internal and external oblique muscles, thus forming a new and larger sac. This sac may attain considerable size.

Treatment.—The hernia is usually reducible; but in many cases reduction is attended with great difficulty, and owing to the position of the testis in the canal the rupture cannot be satisfactorily controlled. The majority of these cases should be treated by operation, unless some contra-indication is present.

In the female, a hydrocele of the canal of Nuck may have the same causal relation that the retained testis has in the male.

HERNIA OF THE CECUM.

The cecum may be found in all forms of herniæ, though it is most often seen in right inguinal. In rare cases it has been found in left inguinal, and even in left femoral herniæ (one of the writers has operated upon a case in which the appendix occupied the sac of a left inguinal hernia). This form of hernia is more frequent than is generally supposed. Of 470 cases operated upon by one of the writers, the cecum was found in 14 cases. The cecum may be found either alone or accompanied by the vermiform appendix. The appendix not infrequently becomes adherent. If free, the better plan is to return it to the abdominal cavity; but if extensive adhesions are present, it may be wiser to remove it. The writers have done this in 5 cases without harm. There are two distinct varieties of cecal hernia:

1. Where the cecum has a mesentery and is completely invested with peritoneum. This form is more often seen in adults. The cecum is found in the sac, as is any other portion of the intestine. The idea so long held, that a " cecal hernia has no sac," has been shown by Treves to be false, or to be only partly true.

2. The second variety is spoken of as **congenital cecal hernia,** and is found only on the right side. It is undoubtedly caused by the traction of the gubernaculum, the uppermost fibers of which are attached to the mesocecum or to the peritoneum of the iliac fossa. According to Treves, in this variety of hernia " the gubernaculum drags the peritoneum down bodily from the iliac fossa, and actually brings it into the hernial sac. The cecum comes with it, and bears exactly the same relation to it as it did to the parietal peritoneum in the pelvis. If the cecum was free in the abdominal cavity, then it lies free in the hernial sac, which is complete in all its parts. If no mesocolon is present, the bowel is found to be adherent to the posterior wall of the sac, and that part of the sac is more or less wanting."

Sigmoid Hernia.—The sigmoid flexure may form the whole or a part of the contents of the sac in a left inguinal, and more rarely in a left femoral, hernia. Much that has been said of cecal hernia applies also to sigmoid. The sac may be partially wanting. This variety is much rarer than the cecal form in children, though in adults it is nearly as common.

VENTRAL HERNIA.

This term is applied to protrusions through the abdominal wall in other regions than those already described. The hernial orifice is usually found at the site of some congenital defect in the aponeurotic layer, most frequently in the linea alba or linea semilunares, or in some cicatrix following a wound or an incision of the abdominal parietes.

They may be classified as follows: 1. Epigastric hernia; 2. Separation of recti muscles; 3. Lumbar hernia; 4. Hernia following abdominal wounds or incisions.

FIG. 203.—Epigastric hernia.

Epigastric Hernia.—This term is applied to all herniæ situated between the umbilicus, xiphoid cartilage, and costal arches. The great majority are found in or very near the linea alba or in the lineæ semilunares. This form of hernia was first described by Garangiot in 1743; but the term gastrocele was applied to it, because the stomach was believed to form part of the contents of the hernia. It occurs in somewhat less than 1 per cent. of all hernia-cases, 137 having been found by Berger out of a total of 16,800 examined. Far too little prominence is given to this variety of hernia in the text-books on surgery. It occurs much more frequently in males than in females; out of a total of 202 cases collected, it occurred 178 times in males and 24 times in females. It is usually found in adult life, and hence is an acquired hernia. It may, however, occur in children and infants. Two cases have recently been observed in infants at the Hospital for Ruptured and Crippled, the hernia in these cases undoubtedly being congenital.

As regards its **etiology**, this variety of hernia may be due to embryonal defects, trauma, or, according to the theory of Wizel, to the action of the extraperitoneal fatty tissue. According to this theory, given a very slight rent or defect, or a weak place in the fascia, the subperitoneal fat is forced through this opening by the intra-abdominal pressure, and later, by traction, carries with it the parietal peritoneum, thus forming a hernial sac. Personally, we do not endorse this view, believing that the majority of cases are due to congenital or acquired defects in the fascia. Direct trauma is responsible for many cases. The onset is usually slow

and insidious, but the symptoms attending the hernia, even when it is of small size, are usually well marked and often severe. Gastric symptoms are present in 80 per cent. of the cases; appetite is variable, and nausea and vomiting are frequent, especially after eating.

The great majority of these herniæ are situated within a few inches of the umbilicus; two or three small herniæ may be present in the same subject, although one is the rule. This variety of hernia seldom attains large size, the usual size being that of an English walnut; in a few rare cases the hernia may reach the size of an orange. The sac is usually empty or contains only omentum.

The **diagnosis** is seldom difficult, provided careful examination be made. Fatty tumor may be mistaken for an epigastric hernia, but the symptoms will nearly always enable us to differentiate the two.

Treatment.—Unless the patient's age or the coexistence of other trouble contra-indicates, epigastric hernia should be treated by operation.

Separation of the Rectus Muscle.—This may occur either in children or in adults, but is more common in the latter; and is usually found in women with lax abdominal walls. In children, it consists in a thinning of the linea alba; and is rarely found below the umbilicus, but almost invariably above it.

Ventral Hernia following Laparotomy.—During the past ten years these herniæ have become very common; 340 cases have been treated at the Hospital for Ruptured and Crippled during the last six years; and from a careful analysis of these cases the writers have deduced the following conclusions: Hernia follows wounds below the umbilicus more frequently than it does wounds above; and it occurs far oftener as a result of wounds that healed by granulation than in those that closed by primary union. It also bears a definite relation to the length of the incision, being much more common after a long incision than after a short one. Some difference of opinion exists as to whether it is more liable to occur after wounds of the linea alba or in those in the muscular planes. Treves believes it is less frequent in the linea alba, and with this view we concur.

Lumbar Hernia.—This term is applied to the rare variety of hernia in which the orifice is situated in the triangle of Petit—*i. e.* the space bounded above by the last rib, below by the iliac crest, and on either side by the latissimus dorsi and external oblique muscles. Most of the cases are either of traumatic origin or are due to an abscess situated in this location. Macready has collected 26 cases of spontaneous lumbar hernia. The writers have observed but 2 examples at the Hospital for Ruptured and Crippled: 1, a spontaneous hernia; the other, due to an abscess following caries of the spine. Lumbar hernia is more common in male than in female subjects; and it is a condition chiefly found in adult life, only 3 out of 23 of Macready's cases occurring in children. It is worthy of note that the 2 cases observed by the writers were in children under two years of age. The hernia is almost always reduced without difficulty, although it is not easily controlled by any form of truss; and a special support should be constructed to suit the individual case. In 6 of Macready's cases strangulation occurred; 3 of these were reduced by taxis, and on 2 herniotomy was performed.

The operative treatment is similar to that described under Ventral Hernia.

OBTURATOR HERNIA.

This is another rare variety of hernia. It was first described by Arnaud, but more clearly by Garangiot, in the beginning of the eighteenth century. It occurs in the canal occupied by the obturator

vessels and nerve. The sac of an obturator hernia is composed of the pelvic peritoneum—in some cases, of the broad ligament and a portion of the fascia of the obturator internus muscle. The contents of the sac consist, as a rule, of bowel alone. The hernia comes out beneath the obturator externus muscle, forming a small tumor just below the inner portion of Poupart's ligament, and hence well to the inner side of the femoral vessels. The hernia is always small, and may even be so insignificant in size as to make it impossible to detect any tumor at all on palpation.

Clinical Features.—On account of its concealed location, obturator hernia is usually overlooked until symptoms of strangulation appear. These symptoms—being those already described under Strangulated Hernia—need not here be repeated. The more common symptoms are constipation, occasional attacks of abdominal cramps lasting for a few hours, sometimes nausea, but seldom vomiting. The reason why the symptoms are less marked than in an ordinary strangulated hernia is because it is in many cases a partial enterocele, or Richter's hernia. The hernia can best be detected with the thigh rotated outward, flexed, and adducted. The finger should then be passed along the pubic bone behind the adductor longus, where the tumor should be felt. Examination by vagina or rectum should always be made, since in some cases the tumor can be felt only by such an examination. Pain caused by pressure on the obturator nerve is a symptom that should never be overlooked; it occurred in 42 per cent. of the cases collected by Macready. This pain is neuralgic in character; it is often described as a cutting, burning sensation; and is referred to the inner side of the thigh, from the groin to the knee or below it. Some of the most skilful surgeons have mistaken this symptom for rheumatism or simple neuralgia.

Treatment.—Operative treatment is practically the only one worthy of consideration. In view of the position of the canal, a truss is out of the question. Gentle taxis may in a few cases be successful. Pressure should be applied behind the adductor longus muscle, and exerted in an upward, outward, and backward direction—in other words, along the axis of the obturator canal. Even if the hernia be detected before strangulation and successfully reduced, operation should always be advised and an attempt made to close the opening. Unfortunately, few cases are detected before strangulation has intervened, and the mortality therefore is extremely high; it is estimated by Macready at 84.4 per cent. W. Anderson operated successfully upon a bilateral strangulated obturator hernia, this being one of the few recorded cases of a double obturator hernia. We may adopt one of two methods of operation: either make an incision in Scarpa's triangle, separating the pectineus and adductor longus muscles, thus exposing the sac; or make an incision into the abdominal wall above the pubis, reduce the hernia by traction from within, and close the canal at the inner opening. This latter method we believe to be the best, since it gives us a much more satisfactory knowledge of the condition of the bowel involved, which is of the greatest importance when it is remembered that in most cases strangulation had existed upward of seven days before the condition was recognized.

Diaphragmatic Hernia.—This form of hernia more properly belongs to the field of Intestinal Obstruction.

Ischiatic Hernia.—This term is applied to a hernia that leaves the abdomen through the great sacrosciatic notch. This variety is extremely rare, and may be easily overlooked. The sac may contain omentum, intestine, ovary, or part of the bladder. If it attains sufficient size, it may pass below the gluteal muscle and down the thigh; or forward, above the great trochanter, toward the groin. In making the diagnosis, we must consider lipoma, hematoma, abscess, aneurysm of the gluteal arteries, and spina bifida. This hernia is seldom seen in children; and is found in men and women in about the same proportion. Owing to the position of the hernia, no form of truss will be likely to control it, and operation should be advised.

Pelvic Herniæ (*Including Pudendal, Perineal, and Rectal Herniæ*). —Pelvic herniæ occur almost invariably in adults, and are more common in women than in men : 34 out of 40 cases collected by Macready were found in women. They seldom appear in the middle line, the tumor being usually found to the one side or the other, in the ischiorectal region in men, and in women in either the ischiorectal space, the vagina, or the posterior part of the labia majora. To those occurring in the site last named the name "pudendal" is applied.

The **diagnosis** is not, as a rule, attended with difficulty, except in the case of vaginal hernia, which latter variety may be easily confounded with abscess, prolapsus, epiplocele, cystocele, uterine polypus, and vaginal cyst. The sac usually contains only the small intestine; but occasionally any of the organs that normally occupy the pelvis may be found. Reduction is usually attended with little difficulty, and the protrusion can often be well controlled by some form of pessary. If the rupture cannot be retained by any mechanical contrivance, operation is indicated. Strangulation is not a frequent complication.

THE RADICAL CURE OF HERNIA.

The discovery of subcutaneous surgery by Stromeyer, in 1831, marks the beginning of modern operations for the cure of hernia. The first attempts were in the nature of subcutaneous injections of fluids, of a nature more or less irritating, into the tissues about the canal (Velpeau, Pancoast, Heaton, Schwalbe, and Lannelongue). These methods, though for the most part only temporarily effective, have been recently revived under various names, and at present are much employed, especially by irregular practitioners.

The Principles Underlying Operative Treatment.—1. Ligature and removal of sac (Socin). 2. Ligature of sac and suture of canal (Czerny-Risel, Banks, Barker, Championnière, McCormac). 3. Infolding of sac (to form a pad within the internal ring) (Macewen). 4. Torsion of sac and suture in canal (Ball). 5. Torsion of sac and suture outside of aponeurosis (Kocher, Treves). 6. Slitting up canal; high ligation of sac; wound left open to heal by granulation (McBurney). 7. Slitting up aponeurosis of external oblique; high ligation of sac with transplantation of cord (Bassini, Halsted). 8. Transplacement of cord by cutting through the transversalis fascia and severing the epigastric vessels (Fowler).

Modern Methods.—The methods of operation introduced in recent years are so numerous that no attempt will be made to describe all of

them. Many of them differ so slightly that they do not merit a separate name, and most of them depend upon a few general principles that have long been recognized. Of methods at present, or until very recently, employed, those most worthy of note are the following: Czerny's method (1877), Bassini's (1888), Macewen's (1886), McBurney's (1888), Halsted's (1890), and Kocher's (1892).

1. **Czerny's method,** or the **Czerny-Risel,** up to 1890 or later, was very widely used both in Europe and in America. This method consisted of an open incision over the external ring, exposure and isolation of the sac, with ligation of the sac as high up as possible. In the early operations the fundus of the sac was not dissected out, but later this step was added. The external ring was finally closed by means of interrupted sutures of catgut. Other surgeons substituted silk or silver wire. The results of this operation were only moderately satisfactory, the mortality being about 7 per cent. in non-strangulated cases ; and the final results showed about 30 to 40 per cent. of relapses in cases traced beyond two years.

2. **Bassini's Method.**—Bassini, in 1885 (published in 1888), introduced a new principle in closing the canal—viz., transplantation of the cord—and as this method has given superior results to all others, and at present is almost universally employed, a careful description of it will be given. The accompanying cuts (Figs. 264–270) show the principal steps of the operation.

Bassini's Operation as Practised by the Writers (with illustrations from original drawings made from life).—A straight oblique incision is made, beginning at the inner side of the anterior superior spine and $\frac{1}{2}$ inch internal to and parallel with Poupart's ligament, and ending over the center of the external ring. This incision is about $3–3\frac{1}{2}$ inches long in adults, and $2\frac{1}{2}–3$ inches in children. The aponeurosis of the external oblique having been clearly exposed, a director is passed in at the external ring beneath the aponeurosis for a distance of about $2\frac{1}{2}$ inches. The aponeurosis is then slit up with a scalpel, great care being taken not to cut any underlying muscular fibers. The aponeurosis is thereupon dissected back on the inner side nearly to the edge of the rectus muscle, and on the outer side until the shelving process of Poupart's ligament is well exposed. The soft tissues on a level with the external ring or slightly within it are then grasped with a pair of thumb-forceps, and the muscular fibers pushed aside by means of a pair of blunt-pointed curved scissors.

FIG. 264.—Incision in Bassini's operation. The white tissues of the sac are thus quickly exposed, and held by a pair of artery-clamps. The sac and cord are then easily and quickly separated from the overlying tissues, without hemorrhage, with the

thumb and forefinger. In oblique hernia the cord will always be found posteriorly to the sac, closely enveloped in a thin layer of fascia—
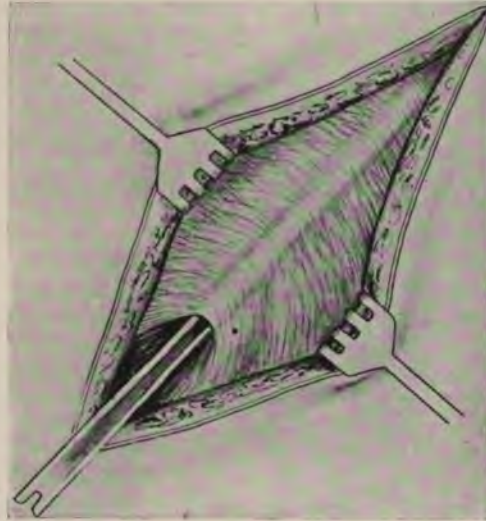
FIG. 265.—Aponeurosis of the external oblique exposed.

the infundibuliform fascia. This layer of fascia is best separated by means of the thumb and forefinger, and the sac is easily isolated from

FIG. 266.—Sac and cord dissected *en masse*.

the cord. Dissection is carried high up until the sac begins to widen out to form the general parietal peritoneum. At this point it is closed

by catgut ligature, if small in size; if large, it is sutured and the lower portion excised. When tied off, the sac should always be transfixed,

FIG. 267.—Isolation and ligature of the sac.

to prevent slipping of the ligature. If the sac be congenital, just enough of the lower portion to cover the testicle is allowed to remain, this being closed by continuous catgut suture. The internal oblique
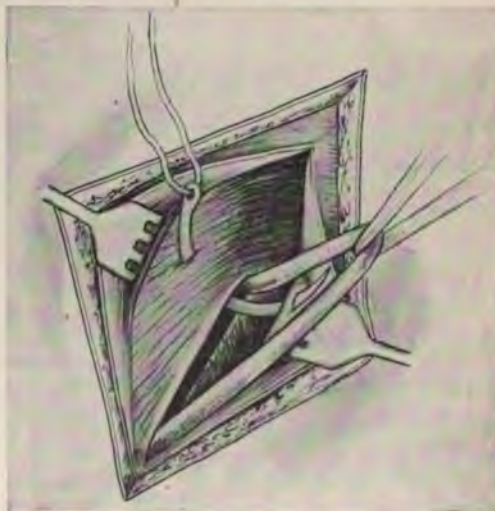
FIG. 268.—Introduction of the first sutures beneath the cord.

muscle should never be cut; in fact, no tissues beneath the aponeurosis are cut. If cut, the edges retract and can never be accurately adjusted or thoroughly united. Cutting of the internal oblique is entirely unnec-

essary, as gentle stretching with the fingers is sufficient to open the canal to the desired extent. The cord is then held up and out of the field of operation by means of a strip of iodoform gauze. Next, the deep sutures of kangaroo-tendon or of chromicized catgut are introduced by a curved Hagedorn needle, as shown in Fig. 267. The first suture enters the internal oblique muscle nearly as far as the outer edge of the rectus muscle, and should just touch the cord when the latter is held vertically to the plane of the abdomen. The suture passes outward through the shelving portion of Poupart's ligament, and is then tied. Three or four similar sutures complete the closure of the canal as far as the symphysis pubis. The lowermost suture includes the conjoined tendon. A suture passing through the same structures is then placed just above the cord. This is not strictly a part of Bassini's technic, but has been added by the writers, and undoubtedly strengthens the canal at its weakest portion—the internal ring. The

FIG. 269.—First row of sutures completed.   FIG. 270.—Aponeurosis sutured over the cord.

cut in the aponeurosis is next closed by means of a continuous suture of kangaroo-tendon, the cord lying directly beneath this layer. Care should be taken to leave sufficient room at the lower end to permit the cord to pass out without undue constriction. The skin wound is then closed without drainage, by means of interrupted sutures of fine catgut. These sutures are almost always found absorbed by the time of the first dressing, which is made at the end of one week.

It should be stated that Bassini himself, in his original paper, advocated silk for the buried sutures, but since 1892 he has employed chromicized catgut.

3. **Macewen's Operation.**—The treatment of the sac is the distinguishing feature of Macewen's operation. The sac is carefully isolated, care being taken to dissect it out entire. The free sac is then drawn, by means of a purse-string suture, into a fold or pad, which is fastened just within the internal ring by the same suture that penetrates the external oblique muscle. The canal is then carefully closed by interrupted sutures of chromicized catgut. The results of this operation in the skilful hands of the originator have been most excellent,

and are hardly surpassed by those obtained from any other methods. The disadvantage of this method, as encountered by other surgeons, is the fact that a large sac not infrequently sloughs, and the long-delayed healing of the wound usually results in a prompt relapse of the hernia. It is not improbable that the success of the method in the hands of its originator depends more upon the careful closure of the canal with chromicized catgut than upon the treatment of the sac.

4. **Halsted's Method.**—This method resembles Bassini's in many features, but differs from it in several essential points. "The aponeurosis of the external oblique muscle, the internal oblique and transversalis muscles, and the transversalis fascia are cut through from the external abdominal ring to a point about 2 cm. (¾ inch) above and external to the internal abdominal ring. The vas deferens and blood-vessels of the cord are isolated. All but one or two veins of the cord are excised. The sac is then carefully isolated and excised beyond the neck, and the peritoneal cavity is closed by fine silk sutures. Six or eight deep mattress-sutures are introduced (beneath the cord), passing through the aponeurosis of the external oblique, the internal oblique transversalis muscle and fascia on the one side, and through the transversalis fascia, Poupart's ligament, and fibers of the aponeurosis of the external oblique on the other." The skin wound is then closed, the cord lying directly beneath it.

It will be seen that the chief points of difference between Bassini's and Halsted's methods are the following: 1. In Halsted's method there is free division of the internal oblique muscle beyond the internal ring, while in Bassini's method this is unnecessary; in fact, it is better not to cut any muscular tissue, the internal oblique being easily pushed aside sufficiently to give a clear exposure of the internal ring. 2. The removal of nearly all of the veins accompanying the cord is advised by Halsted, while in the Bassini operation they are not interfered with.

Atrophy of the testis has followed removal of the veins in a number of Halsted's cases, and the possibility of this result should be borne in mind. O'Connor[1] has recently reported 20 per cent. of atrophy of the testis in 129 cases operated upon by Halsted's method.

5. **Kocher's Method.**—The sac is thoroughly isolated. A slit is made in the aponeurosis of the external oblique (which has thus far remained intact), about 1½ inches above the external ring. The sac is then drawn through this opening and laid back upon the outer surface of the aponeurosis. The canal is closed by a series of interrupted sutures inserted Lembert fashion, so as to bury the sac in a fold of aponeurosis.

Kocher's own results with this method, recently published,[2] are very good; yet the advantage to be derived from leaving the sac in this or in any other position is largely theoretical. Kocher has recently modified his method. The slitting up of the aponeurosis over the entire canal, as in Bassini's method, certainly makes it possible to close the sac on a level with the internal ring without leaving behind any "pouting" process of peritoneum, and at the same time no ill-nourished tissue remains to lessen the chances of obtaining primary union. Treves adopted a method of dealing with the sac similar to Kocher's, only the greater part of the sac is cut away, and the twisted stump is brought out through an incision in exposed tissues at or near the median line.

Suture of the Canal as in Bassini's Method, without Transplanting the Cord.—The writers have employed a method which is exactly the same as Bassini's, with the exception that the cord is not transplanted, but is allowed to drop back beneath the lowermost layer of buried sutures. The internal oblique is united to Poupart's ligament and the aponeurosis is sutured separately with sutures of chromicized kangaroo-tendon, and the skin closed with fine catgut. The results have been nearly as good as those following Bassini's method proper, though the number of cases scarcely justifies a comparison.

Mortality of Operative Treatment.—Excluding early and scattered cases, we have collected 10,000 cases operated during the period

[1] *Med. Press and Circ.*, Jan. 12, 1898.
[2] *Deutsch. Zeit. f. Chir.*, Bd. 38, H. 5 u. 6.

from 1886 to 1897, with a mortality of $\frac{9}{10}$ of 1 per cent. This is exclusive, of course, of strangulated hernia. This shows a marked improvement over the statistics of Leisrink, published in 1882, in which there was a mortality of $11\frac{2}{3}$ per cent. In the latter series of cases 9 deaths were due to sepsis.

Dangers Attending Operation.—A fatal result may occur from faulty ligature of omentum. Omentum should always be tied off in small masses; and if large vessels be present, these should be tied separately. Catgut is preferred to silk as a ligature for omentum. Ligature of omentum too near the bowel has been the cause of death in at least 1 case known to the writers. Suppuration in the omental stump may cause a fatal peritonitis. Ligature of the sac without first opening and examining the contents has resulted in injury to important organs.

Lack of care in dissecting the cord from the sac may easily cause harm to the vas deferens. The vas should always be exposed early in the dissection, and when once found it can easily be kept safe. The vas was cut in 7 cases in Bassini's list of 251 cases. The presence of the bladder in the sac is usually unrecognized until it has been cut into, a mistake that may prove fatal.

In addition to the foregoing, the most serious risks attending a hernia-operation are sepsis and pneumonia following ether. The strictest asepsis and the utmost care in administering the anesthetic are the only means we have to overcome these risks. The lungs should always be carefully examined; and if a bronchitis exists the operation should be postponed. Orchitis may complicate wound-healing, but this is seldom severe.

Choice of Methods.—Only those methods should be employed that have stood the test of time. With equally good results, that method should be selected which is the simplest as regards technic. At present the evidence is very strongly in favor of the superiority of Bassini's method. This method, as stated, has gained in favor until at present it may be safely said that it is more generally employed than any other method. The results in the hands of other surgeons have equalled those obtained by Bassini himself.

Halsted's method, while it closely resembles that of Bassini, differs in the direction of a more complicated technic, which alone would be sufficient reason for choosing Bassini's method, provided the results were the same. As a matter of fact, the published results of Halsted, though excellent, are inferior to those of Bassini. The time required to perform Bassini's operation is much less than for Halsted's.

The brilliant results of Macewen have not been generally obtained by other surgeons attempting to operate by his method.

The transperitoneal method recently introduced by George R. Fowler may in certain cases be preferable to other operations—*e. g.*, in hernia complicated with undescended testis; but the method is yet too recent for judgment to be passed upon it. We see no advantage in the curved incision, and believe the straight incision preferable.

The method which we have employed in a considerable number of cases, and which we have designated as suture of the canal without

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transplantation of the cord, the remaining steps being identical with Bassini's, has, we believe, much to commend it, though as yet our cases are too few in number to enable us to estimate its comparative value. That particular feature of any method which allows the sac to remain behind to be disposed of in various ways, either intra- or extra-peritoneally, we hold, should be given up. Such disposition of the sac undoubtedly lessens the chances of securing primary union, and does not, we think, offer any additional security against relapse. The practice, followed by some surgeons, of using a number of different methods must be condemned for the reason that it is impossible to attain the same proficiency in all that could be obtained in one. Success is dependent in no small degree upon rapidity in operating, thus avoiding bruising the tissues, and thereby contributing to primary union. The use of rubber gloves or of rubber finger-cots promises still further improvement in results.

Results of Operation.—There is no longer room for doubt that hernia can, for a considerable period at least, be cured by operation. Whether these cures will prove permanent we cannot as yet state positively. The proportion of permanent cures cannot be estimated with exactness, inasmuch as no definite limit of time can be laid down beyond which relapse may not occur. In spite of this we are able, from a careful study of the cases operated upon up to the present time, to arrive at certain fairly definite conclusions. The results of our observations, based upon a study of 360 cases of relapsed hernia following various methods of operation, throw valuable light upon the question as to the period when relapse is most likely to occur. We have found that 80 per cent. of these relapses occurred during the first year after operation; 64.5 per cent. during the first six months following operation; while but 11.9 per cent. occurred after a period of two years had elapsed. Of the cases that relapsed after two years, 5 occurred between ten and twenty-two years after operation; 7 between five and ten years. In 100 out of 360 cases of relapsed hernia the operation was done for strangulation. The average period of relapse after operation was found to differ but little in the strangulated and the non-strangulated cases. Thirty-one cases were femoral and 229 inguinal. In 71 per cent. of the cases of relapse the age of the patient was over thirty years; in 29 per cent., under thirty years.

These cases, which were not selected, but were taken as they applied for treatment, ought to give us a fairly accurate idea of the average time when relapse occurs.

From these facts we are, we think, justified in concluding in a general way that, if a rupture is sound at the end of one year after operation, there is reasonable prospect of permanent cure; while if it remains well for two years the chances of relapse are exceedingly small, though it is not impossible that relapse may occur as late as twenty years after operation.

Ninety-five per cent. is probably a conservative estimate of cures following Bassini's operation when properly performed. Of our personal cases, we have treated upward of 200 that have remained free from relapses for periods ranging from two to eight years after operation. One of the writers has had but 5 relapses in 549 cases operated

upon by Bassini's method. Ninety-six per cent. of the cases healed by primary union.

Roux of Lausanne, Switzerland, has operated upon 1398 cases, with 5 deaths. Of these, 324 were traced beyond two years, and 54, or 16.7 per cent. of this number, relapsed. Two hundred and thirty-five of the cases traced were operated upon by the method of Ferari, and only 53 by the method of Bassini, slightly modified by Roux, in that he substituted a purse-string suture for the interrupted suture of Bassini. Of the 53 cases operated upon by this method, 35.8 per cent. relapsed. A study of the wound-healing of these cases is of much interest. Of the cases that healed by primary union, 15.2 per cent. relapsed; of the cases that healed by secondary union, 22.4 per cent.

Halsted has operated upon 440 cases, with 1 death. Of 261 cases traced from six months to nine and one-half years, there were 17 relapses, or 6.5 per cent.; of 230 that healed by primary union, 10 relapsed, or 4.3 per cent.; of 31 that suppurated, 7, or 22 per cent. relapsed.

Macewen has operated upon 164 cases by his own method, with 2 deaths. Of this number, 107 were traced, with 5 relapses; and 93 cases were well from two to ten years after operation.

Broca of Paris (personal communication) has operated upon 1064 cases by his own method, with 9 deaths; a very large proportion of these cases were children. The number of cases traced is not stated.

Perfect primary union should be regarded as of the very highest importance to the success of any method. The choice of suture-material is only second in importance to choice of method. Many of the earlier failures were undoubtedly due to too rapid absorption of the simple catgut sutures; while many of the failures of to-day are due to the use of non-absorbable sutures which may cause the development of slow-healing sinuses, which so weaken the canal as to invite speedy relapse. That this is not a purely hypothetical danger is shown by the fact that 26 cases have been observed by the writers at the Hospital for Ruptured and Crippled during the past seven years. Silk, silver wire, and silkworm-gut were all represented in these cases.[1]

Some of the patients were incapacitated for work for months, and in one case nearly a year. In another case, in which the original wound had healed by perfect primary union, sinuses developed at the end of six months, two and one-half years, and three years and eight months, and did not heal until the offending sutures (in this case silkworm-gut) had been removed. In the great majority of the cases relapse occurred. Delorme notes that sinus developed later in 11 cases in 100 in which primary union occurred originally.

The best sutures for a hernia-operation we believe to be an absorbable suture that will remain in the tissues several weeks—*i. e.*, a sufficient time for the firm union of the semitendinous structures that have been brought into apposition. Chromicized kangaroo-tendon or chromicized catgut are the sutures that in the present state of our knowledge best fulfil these conditions. A point of great importance, though but seldom referred to, is the size of the suture. Too large a suture, even of tendon or catgut, would be open to the same objection (though to a less degree) to which attention has been called in the non-absorbable sutures. The suture most suitable for the deep musculo-aponeurotic layers should be about the size of No. 3 catgut; that for the aponeurosis, the size of No. 2 or No. 1 catgut. It is difficult to get uniform sizes in tendon-sutures, and in this fact lies the chief objection to such suture-material, although the greater expense is also to be considered.

The writers have used this material for buried sutures in 1000 hernia-operations with most satisfactory results. Its superiority to catgut was originally brought to the notice of English surgeons by Girdlestone of Australia, in 1882,[2] and Marcy has long been an enthusiastic advocate of it in America.

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[1] Jacobson states: "In a certain and large proportion, I know from experience that silk can be used; but in a considerable number this and other materials most certainly cause trouble later on. The wound runs an aseptic course, heals without suppuration, and then, after varying periods, a sinus appears, and one or more of the sutures have to be removed."

[2] *Medico-Chirurg. Transactions*, 1883.

Indications and Contra-indications for Operation.—Children.—Operations in childhood and youth give the best results with the lowest mortality. Broca of Paris has operated upon 475 children, with but 2 deaths and 3 relapses in 250 traced. Coley has operated upon 450 children, with 1 death and but 3 relapses. Operation should not, as a rule, be advised in children until a truss has been carefully tried without benefit. It is, we think, seldom indicated under the age of four years, though Broca operates in children much younger. The majority of children are cured by mechanical treatment, though about one-third go on to adult life with the hernia uncured. Herniæ in children complicated with irreducible or adherent omentum,[1] or with reducible hydrocele, also all cases of femoral hernia, are best treated by immediate operation. Early operation may also be advised in cases unable to obtain the care requisite to successful mechanical treatment. Umbilical herniæ in infancy or childhood should seldom, if ever, be treated by operation. Save the very rare variety "congenital hernia of the cord," umbilical hernia in infants and children is almost always cured before the age of puberty—spontaneously or by a simple support.

Adults.—In adults operation may be advised in most cases under fifty years of age, provided the subject be in good health and the hernia is not too large. Operation is not to be recommended in very voluminous herniæ in middle life. In these cases the contents are usually adherent; the operation is prolonged, difficult, and attended with no small risk. Relapse likewise is almost sure to follow. Young adults with good muscular development are excellent subjects for operation. The prospect of permanent cure without further use of a truss is very good; while without operation there is little chance of a cure. Adherent or irreducible omentum in subjects not too aged or in herniæ not too large is best treated by operation.

Undescended or Partially Descended Testis.—This condition is frequently seen in infants and in boys under the age of fourteen, and is very often associated with a small hernia. The question of operation in such cases is a very important one, and one which at present cannot be regarded as definitely settled. The writers have operated upon 20 cases of this kind, and in a number of them efforts were made to draw down the testis and anchor it in the scrotum. But thus far such efforts have met with little success. Anchoring the testis to the thigh has been recently advocated. While there has been no relapse of the hernia, the testis soon retracted into the vicinity of the external ring, and either showed no further development or became more atrophied. From this limited operative experience and from an extended observation of a very large number of such cases treated mechanically, we are at present inclined to advise against operation in the majority of cases. If left alone, or treated, as Macready advises, by a truss with the pad resting above the testis, in most cases the testis will have reached the scrotum before puberty, and the rupture will probably have been cured. If not, operation can then be performed under more favorable conditions.

Umbilical Hernia.—Operation should seldom be advised in umbilical

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[1] In 375 cases of children operated upon at the Hospital for Ruptured and Crippled, reducible hydrocele was found in 8 cases, and adherent omentum in 4.

hernia in adults. The majority of these cases are found in stout women of middle age, with abdominal walls containing but little muscular and a large amount of adipose tissue, conditions most unfavorable for a firm union. Moreover, these herniæ are generally very large, and the contents, made up of omentum and bowel, almost always firmly adherent to the sac. Aside from the risk of operation, which is considerable, the cure is seldom permanent. Women under thirty or thirty-five, with umbilical hernia of moderate size, may be properly subjected to operation. In brief, our efforts should be mainly directed to the younger generation, preventing the development of such conditions that we must now recognize as beyond our help.

Operative Treatment of Femoral Hernia.—In operating for

FIG. 271.—Operation for femoral hernia: " purse-string " method.

femoral hernia, many surgeons have attempted to do little more than to tie off the sac high up and close the skin wound; and up to 1890 the results showed that at least one-third of the cases relapsed. Later, in addition to removing the sac high up, various ways of suturing the femoral canal were introduced.

High ligation of the sac, with closure of the canal by means of a purse-string suture of chromicized kangaroo-tendon or chromicized catgut, is a method that has given perfect results in the hands of the writers. Coley has employed this method in 35 cases, with no relapses. Bassini's method for femoral hernia, brought out in 1894, is worthy of special note. The method is, in brief, as follows:

The incision is made parallel with and just below Poupart's liga-
ment. The sac is dissected free from the canal and ligated as high
up as possible. With a curved needle three sutures are inserted so
as to unite Poupart's ligament with the pectineal fascia, the first being
placed near the spine of the pubis, the second $\frac{1}{2}$ cm. externally, and the
third 1 cm. from the femoral vein.

These sutures remain united until three or four others have been
inserted, the first through the edge of the falciform fascia, then the pec-
tineal fascia, the lower suture entering just above the saphenous vein.
The upper sutures, which draw Poupart's ligament backward to the pec-
tineal line, are fastened. The other sutures, which bring together the

FIG. 272.—Bassini's method for femoral hernia.

anterior and posterior walls of the canal, are next tied; and lastly the
skin-incision is closed without drainage. The illustration (Fig. 272)
shows the position of the sutures. Bassini has operated upon 54
cases by this method, with no mortality and without a single relapse
in 41 cases traced from one to nine years.

One of the writers has employed this method in 15 cases, with no
deaths and 1 relapse; kangaroo-tendon was substituted for silk in the
buried sutures.

Results of Operation in Umbilical and Ventral Herniæ.—In
the majority of umbilical herniæ operation is not to be advised. In suitable
cases the best method is the following: An elliptical incision, including
umbilicus and redundant portion of skin; free dissection of the sac until

the aponeurosis covering the rectus muscle is clearly seen; removal of sac and redundant skin, with excision of adherent omentum if present; closure of the wound in three layers. The peritoneum should be carefully united with catgut, the aponeurosis and recti muscles with chromicized tendon or catgut, and the skin with catgut or silkworm-gut. Drainage is seldom necessary.

The results are by no means as good as those obtained in inguinal and femoral hernia. We have operated upon 34 cases, with 12 relapses and 21 cases traced. In irreducible cases, the mortality may be said to be not far from 5 per cent., increasing or diminishing with the size of the hernia and extent of the adhesions.

The Advisability of a Truss After Operation.—This is a question of some importance, and one upon which there is at present little unanimity of opinion. Jacobson[1] states that "each case must be judged separately. As regards children, from the experience I have gained from my cases, I think, if the recumbent position be insisted upon for three months after operation, so as to give the newly restored parts time to consolidate firmly, a truss will not be subsequently required."

Personally, we never advise a truss in children after operation, and we consider a recumbent position for three months entirely unnecessary. Our experience, based upon a series of upward of 600 cases of hernia in children under fourteen years of age, has shown that two to two and one-half weeks is ample time for the child to remain in bed. The subsequent history of these cases has been traced with scrupulous care, and some of them have been well upward of seven years. Even in adults we very seldom advise a truss after operation. There are, however, certain cases in which a permanent cure will be more likely to be obtained if a support be worn after operation. Such cases are those beyond middle age, with poorly developed and flabby abdominal muscles and a superabundance of fat. We would also include cases in which the hernia is of unusual size in adults past middle life.

[1] *Operations of Surgery*, 3d ed., 1897.

CHAPTER XVI.

DISEASES OF THE RECTUM AND ANUS.

Anatomy.—The rectum is about 8 inches in length, commencing at the left sacro-iliac synchondrosis and gradually approaching the middle line. Its upper 3 inches has a complete mesentery, by which it is supported; below this it lies in the concavity of the sacrum; while its lower extremity is slung, as it were, in position in the pelvis by means of the levator ani muscle and the rectovesical fascia, the latter dividing the perineum from the pelvis, and blending intimately with the structures of the rectum just above the external sphincter. The external sphincter, the anus, and the immediate termination of the rectum may thus be considered to occupy the perineum, while all that portion above the reflection of the rectovesical fascia is a true pelvic organ.

The lowest portion of the rectum—viz., that included within the sphincters, and properly called the anal canal—has a direction somewhat backward, so that in passing the finger, a bougie, or an enema-tube the direction at first taken is in a line approximately toward the umbilicus. Immediately above the internal sphincter the bowel abruptly expands into an ampullar space capable of being distended to an enormous size by fecal accumulation. This portion curves backward and occupies the hollow of the sacrum. In this section are also found certain longitudinal folds of mucous membrane produced by the narrowing of the ampulla just above the internal sphincter. They were called by Morgagni the "columns" of the rectum. Houston's folds are transversely disposed, one projecting backward from a point opposite the prostate, a second from the left side opposite the middle of the sacrum, and a third from the right side somewhat higher up. In the empty condition of the bowel these are $\frac{1}{2}$ inch in depth, or more, overlapping one another in a valvular fashion, and may cause some embarrassment in passing a rectal tube; but under distention with gas, fluid, or feces they almost entirely disappear.

The fold of peritoneum between the rectum and bladder in the female, known as the pouch of Douglas, reaches to within $3\frac{1}{2}$ or 4 inches of the anus. From this point upward the serous membrane gradually invests more and more of the tube, so that at its upper portion, about 5 inches from the anus, not only is the bowel covered on all aspects by peritoneum, but the junction of the two folds behind forms a complete mesentery. In the female, the vagina and uterus lie between the rectum and the bladder, and these, with the Fallopian tubes and ovaries, may usually be readily palpated with the finger in the bowel.

The peculiarities of the blood-supply will be considered when dealing with the subject of hemorrhoids.

The skin about the anus is thin, delicate, pigmented, and thrown into radiating folds by the tonic contraction of the external sphincter. It is abundantly supplied with nerves, and the exquisite painfulness of ulcers and fissures of the part is thus explained. An important landmark, which, however, is not always well marked, is a fine white line (Hilton's) at the junction of the skin and mucous membrane, corresponding closely also to the interval between the internal and external sphincters.

Congenital Malformations.—The rectum is formed from the hinder part of the primitive gut of the fetus, and is therefore developed from hypoblast and mesoblast. It is further complicated by the development of the allantois, which buds out from its anterior surface as a hollow, finger-like process, the proximal portion of which subsequently becomes the urinary bladder.

The anus, on the contrary, is produced by an invagination of the epiblast, called the proctodeum, which, as development proceeds, joins the hind-gut by an absorption of the intervening septum. The external opening thus produced is relatively large, elongated from before backward, and is really a cloaca—that is, it is common to the alimentary tract and the genital and urinary organs. In the male, this cloaca becomes divided by the fusion of septa, which grow in from the sides, into a smaller anterior tube, the urethra, which

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also receives the genital ducts, and a larger posterior canal, the anus. The median fusion of these lateral septa also· forms the perineum, the scrotum, and the inferior wall of the penis and urethra. In the female, similar lateral septa separate the anus from the uterus and vagina, the urethra being formed simply from a narrowing and slight elongation of the allantoid pedicle.

It follows, then, that an interruption or failure of this developmental process at any point may result in a corresponding malformation. Of these, the following are the most important: 1. Anal cul-de-sac and hind-gut both developed, but with failure of absorption of the septum. 2. Anal cul-de-sac developed, but imperfect development of the hind-gut, so that several inches of dense tissue may separate the two. 3. The anus may not be developed, in which case the hind-gut (a) ends

FIG. 273.—Malformation of anus. Enterodeum (hind-gut) continued as a tapering, tortuous tube (a) along the raphe of the scrotum, and ending by a minute opening (b) discharging meconium near the end of the penis; c, anal depression—imperforate.

blindly; (b) opens upon some part of the perineum, scrotum (Fig. 273), or by a narrow canal at the end of the penis; (c) opens into the urethra or bladder in the male, or the vagina—rarely the uterus (Croft)—in the female.

Symptoms and Diagnosis.—The symptoms of these conditions always make themselves apparent soon after birth; though if the anus be well formed, absence of the escape of meconium may be set down to constipation; while if there is a fistulous opening through the vagina, the true condition may not be discovered for some time. Where no fistulous opening exists, vomiting and colicky pains are frequently present, and an unhealthy, icteric hue quickly develops. The escape of meconium by the urethra or from the vagina speedily establishes a

diagnosis; though it is not by any means easy to learn at what point in the canal the fistulous communication has occurred. When no feces have passed within a reasonable time after birth a careful digital examination of the anal region should be made without delay.

Treatment.—When obstruction is complete, it is obvious that the prognosis is hopeless without operative treatment of some kind. As a rule, also, the simplest and least severe operation is the best. The writer lost 2 apparently favorable cases from hemorrhage, due to the icteric condition of the blood, after simply dividing a thin septum.

If the septum is thin, a very small opening should be made at first. This may be dilated after the child has acquired more strength. If the hind-gut does not reach nearly to the anus, a more extensive dissection will be necessary; and if this is not successful, no time should be lost in performing an inguinal or lumbar colotomy.

When, owing to a free discharge through a fistulous opening, there is no great urgency, all plastic operations should be delayed until the child has acquired strength and endurance.

Foreign Bodies.—Of foreign bodies that reach the rectum by descent through the alimentary canal, small bones of fish and game are the most frequent. Gall-stones, enteroliths, and the multifarious bodies that may be swallowed by lunatics are relatively rare. If undiscovered or neglected, they frequently give rise to pain on defecation, fistulæ, or fistulous communication between the rectum and vagina or bladder. Among foreign bodies introduced from below are those which enter as the result of accident, and those which are introduced from morbid motives by lunatics and others. Their effects are serious in proportion to their size and nature, and the treatment must be conducted in accordance with general surgical principles.

Injuries of the Rectum and Anus.—The rectum is occasionally injured by severe crushing fractures of the pelvis; but much the most common cause is the violence of foreign bodies acting through the anus or perineum, as in a case seen by the writer, in which the pole of a wagon passed through the anus and perineum of a boy, entered the peritoneum, and permitted immediate prolapse of the intestines, with a rapidly fatal result. Impalement upon picket-fences or stumps of trees in falling from a height, or violence from perforating bodies of any kind through the anus or perineum, produces dreadful injuries which frequently tend to a fatal issue despite the best efforts of the surgeon. Apart from the immediate dangers from shock and hemorrhage, which are not inconsiderable, the most threatening features are the occurrence of septic cellulitis with sloughing in the pelvis, and septic peritonitis.

Less fatal, though still serious, are injuries produced by rupture or sloughing from pressure during childbirth. Surgical procedures, such as the distention of a Petersen's bag in the rectum during suprapubic cystotomy, the introduction of Davy's lever to arrest hemorrhage during amputation at the hip-joint, the passing of bougies or the rectal tube, accidental wounding of the rectum during lithotomy, the unskilful administration of enemata, the injudicious introduction of the hand in making rectal examinations, have all produced disastrous and frequently fatal results.

Diagnosis.—The diagnosis can be difficult in those cases only in which the injuring body has passed through the anus, leaving it intact, and expended its violence upon the walls of the rectum higher up. Usually there is a great deal of shock, and, though some blood will generally escape from the anus, it must be borne in mind that large quantities of blood may be effused into the cellular tissue, the lumen of the bowel, or the peritoneal cavity when that is involved. Examination

should be conducted in a strong light, with a wide speculum, and with the patient under anesthesia. The knee-chest or the Trendelenburg position would be favorable were it not for the danger that in case of wound of the peritoneum feces, blood, or foreign matter might be sucked or pumped into that cavity.

Treatment.—The treatment will depend upon the extent and character of the wound, and it requires the exercise of great judgment on the part of the surgeon. The dangers of septic cellulitis and peritonitis are to be borne in mind, and measures taken accordingly. The patient should be anesthetized, the edges of the wound held apart, and all bleeding points secured. All feces, blood, and foreign matter should then be wiped away, or removed by means of a copious, but not forcible, stream of antiseptic fluid. The surgeon should then endeavor to ascertain the exact extent of the wounds, and in order to do so it is quite justifiable to enlarge the skin wound if necessary. If the peritoneum is torn but slightly, and there is good reason to believe that no foreign material has entered the cavity, it may be stitched up either with or without drainage, according to the discretion of the operator. If the wound is more extensive and complicated with the introduction of foreign matter, it is appropriate to open the cavity above the pubes, make a thorough cleansing, and establish adequate drainage through one or both wounds. Whenever possible, it is certainly advisable to stitch up the bowel by two or three rows of silk or catgut sutures, paying special attention to the apposition of the sphincters, and endeavor to secure healing by first intention. Free drainage of the perirectal tissues should be provided by packing the whole wound lightly with iodoform gauze. The dangers of spreading cellulitis would be thus minimized, and the wound will heal well by granulation.

It is impossible to insist too strongly upon the mechanical as well as the chemical disinfection of these wounds ; and it must by no means be taken for granted that because the injury is connected with the rectum it is impossible to maintain asepsis in the healing of the wound. It is quite true that the effort will frequently fail, but no harm and much good will result from the attempt.

The dressing and after-treatment are important. Thorough drainage must be secured, even at the expense of a slow healing of the wound. Iodoform in moderate quantities may be rubbed into the wound and gauze drains inserted. If it is thought advisable to pack the rectum with antiseptic gauze, a fair-sized rubber tube should be placed at the side of the bowel opposite the wound, in such a way as to conduct gas from the bowel above to the anus. This will add greatly to the comfort of the patient. Opium should then be given to lock up the bowels, so as to leave the parts undisturbed during the first few days of healing. Indeed, one can conceive of cases in which a temporary inguinal colotomy would not only be admissible, but would add materially to the chances of recovery.

Abscess in connection with the anus and the rectum may commence in any of the following situations : 1. In the skin adjacent to the anus, in connection with a hair-follicle, or as an infective process connected with a small ulcer or fissure of the anus. 2. Just beneath the mucous membrane of the anal canal at its upper part—" anal abscess."

3. Deeply in the ischiorectal fossa. The first variety is usually merely a furuncle which ruptures externally, or is lanced and closes without leaving any fistula. If neglected, however, or if the skin is unusually dense, the abscess may spread deeply, so as to occupy the ischiorectal fossa, and denude the rectum widely. For this reason it is imperative to lay open the suppurating focus as soon as discovered.

The second variety, or *anal abscess*, constitutes, according to Erichsen, the most common cause of fistula in ano. It may originate from the irritation or impaction of a fish-bone or other undigested substance, or may be the result of suppuration beneath an inflamed pile. In some instances it is tubercular in origin. It frequently ruptures both internally and externally, leaving a thin-walled fistula which refuses to heal until slit up and scraped or packed with iodoform gauze.

Much the most serious form is the *ischiorectal abscess* proper. This occurs in the acute form and as a very chronic process. Both forms occur most frequently in those who are of feeble constitution, or whose resisting power has been lowered by disease.

Acute ischiorectal abscess may arise as the result of a blow or kick in the perineum; exposure to cold and wet, as in sitting upon damp grass or a stone after active exercise; or from perforation by a foreign body from within the rectum.

The *symptoms* are very acute and painful in character. The pain is stabbing or throbbing, deep-seated, and greatly increased on movement and on defecation. On examination, a hard, brawny swelling is discovered at one side of the anus. It may be red or dusky in color, and may pit on pressure. The finger passed into the anus discovers the canal encroached upon by the abscess, which often bulges beyond the median line and gives the lumen of the bowel a crescentic shape. Usually the abscess is limited to the lateral aspect of the pelvis; but if neglected, it may dissect around both in front and behind the rectum and reach the opposite fossa. If left untreated, it tends to rupture both internally and externally. The external opening may be at some distance from the anus, but the internal opening in the majority of cases is between the internal and external sphincters, just within the anus. This is doubtless explained by the density and resistance of the anal and rectovesical fasciæ, which blend with the bowel-wall just above this point.

Treatment.—It is obvious that early incision is necessary to prevent extensive loss of areolar tissue and wide denudation of the rectum. The patient should be anesthetized and an incision made from before backward the whole length of the abscess. The pus which escapes will be mixed with sloughs and will have a distinctly fecal odor. The finger should now be inserted and used as a curet to remove all the sloughs from the walls as cleanly as possible, the mechanical cleansing being completed by swabbing with iodoform gauze soaked in carbolic acid (1 : 20). The bleeding will be very free at first, but it is easily controlled by packing with iodoform gauze. A perineal bandage over a bulky absorbent dressing is then applied, and the wound left undisturbed for thirty-six or forty-eight hours. When the packing is removed the wound will generally be found to be clean; but if any pus be present, it may be wiped out or irrigated away, and a small quantity of gauze placed lightly in the wound. It will usually be found that the walls of

the abscess collapse and become adherent in a very short time; and if pains are taken to keep the external wound widely open, so as to allow perfect drainage, complete healing without a fistula will usually occur.

Chronic Ischiorectal Abscess.—As the term implies, this form differs from the acute in being less virulent in its symptoms; but it is really the more serious condition of the two, since its ultimate result is generally less satisfactory. The causes are similar to those of the acute form, but, in addition, the patient is usually of a strumous or·tubercular constitution, and in many instances the abscess may be the direct result of tubercular disease of the rectum. Abscesses of this class not rarely attain a considerable size without attracting the notice of the patient, and the first symptom to attract his attention may be the escape of pus from the bowel or through an external opening. The physical signs are similar to those present in the acute form, with the exception that narrow, indurated sinuses may extend across to the opposite side, outward upon the buttocks, forward to the perineum or scrotum, or backward over the coccyx and sacrum. Sometimes several openings may form in these situations, as well as one or more openings into the bowel. When the abscess, after evacuation, has dwindled to a sinus, these openings form the variety known as *horseshoe fistulæ.*

Treatment.—The principles of treatment are the same as those laid down for the acute form, but great care must be taken to follow up all the sinuses, laying them freely open, and scraping their indurated walls vigorously with a sharp Volkmann's spoon. Should one or more of these sinuses lead into the bowel, it will be necessary to divide the sphincter; but this should only be done at one point, lest incontinence of feces result. Usually by scraping out the remaining sinuses, the rest secured by a single division of the sphincter will be sufficient to insure healing. The operation of scraping and packing may require to be repeated in obstinate cases.

Fistula in Ano.—This condition usually results from neglect in the treatment of one of the preceding maladies. When an anal or an ischiorectal abscess ruptures spontaneously the patient experiences such a sense of relief that he fondly imagines he is at an end of his trouble, and consequently neglects seeking surgical aid until the abscess evacuates itself and dwindles to a mere sinus, with one or more openings in the skin, in the bowel, or in both. A precisely similar result follows inadequate treatment on the part of the surgeon, or, in tubercular cases, may follow despite his most skilful care.

The varieties usually described are: 1. The complete or true fistula (pipe) (Fig. 275, *A*) with two openings, one on the skin and the other into the lumen of the bowel. This variety may have numerous lateral offsets, which in turn may terminate in openings

FIG. 274.—*D*, horseshoe fistula. The continuous lines show the incisions necessary.

either internally or externally (horseshoe fistulæ) (Fig. 274, *D*). 2. The blind internal fistula (Fig. 276, *C*)—really a sinus having an internal but

no external opening.   3. The blind external fistula (Fig. 276, *B*), which is the converse of the preceding.

For reasons explained when speaking of abscess, the internal opening is usually (90 per cent. of cases, Allingham) a short distance within the anus, between the internal and external sphincters (Fig. 275). Sometimes the sinus approaches the lumen of the bowel at this point, and then dissects upward beneath the mucous membrane, which it perforates at a

FIG. 275.—*A*, complete fistula.   The continuous lines show the incisions necessary.

considerably higher level.   More rarely, the abscess strikes inward high up in the fossa, perforates the rectovesical fascia and levator ani muscle, and enters the bowel above the internal sphincter (Fig. 275, *A'*).   This constitutes the most serious form of fistula.   The external opening is usually situated a short distance from the anus.   It may be extremely small, and appear as a small area of granulations at the apex of a diminutive pyramid near the anal orifice.   On pressing the base of this a drop of pus
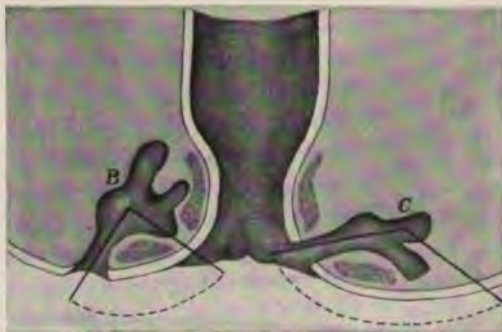
FIG. 276.—*B*, blind external fistula; *C*, blind internal fistula.

may exude.   In other instances the opening is easily detected, and may be seated from 2 to 5 inches, or even farther, from the anus, in almost any direction.   Frequently an indurated cord can be felt running from the external opening toward the bowel.

Symptoms.—The symptoms may vary greatly with the extent and variety of the fistula.   A small blind external fistula may give rise to but little pain or discomfort, the patient's chief annoyance being from

the irritation and discomfort produced by the intermittent discharge of a small quantity of pus.

In the blind internal fistula the symptoms are frequently intermittent in character, the attacks being due to lodgement of feces in the mouth of the sinus, or an accumulation of pus due to partial closure. Relief is accompanied by a more or less copious discharge of pus, which may escape from the anus in the act of defecation.

In the complete form the symptoms are more constant, and consist of pain on defecation, moisture about the anus due to discharge of pus or liquid feces, itching and irritation, with sometimes a spasmodic and painful condition of the sphincters. On examination, more or less induration is generally present in the perineal region. Probing should be carried out with a blunt flexible instrument and with a very light hand, so that the probe, bent as may be required, may find its own way along the sinuses. The finger should not be inserted within the anus until the probe has almost reached the mucous membrane, lest its progress be arrested by spasmodic contraction of the sphincters.

Treatment.—The principal reason why fistula refuses to heal without operative treatment is that the involved tissues, at every act of defecation and at frequent intervals between, are in movement by the contractions of the external sphincter, the levator ani, and the intrinsic muscles of the bowel itself. The external sphincter, through its attachment to the skin, draws the wall of the sinus in one direction, while the other muscles act by exerting traction in its upper limitations. Consequently, to give the necessary rest to the diseased area, it becomes necessary in all except perhaps the most superficial cases to divide the external sphincter by laying open the whole sinus between its internal and external openings. This should generally be done while the patient is under full anesthesia, otherwise the lateral offset, if any, which should also be laid open, may escape recognition. The usual method, and perhaps the best one, of accomplishing this is to pass a grooved director along the fistula from the external opening into the bowel, seize this end by the finger introduced *per anum*, draw it down, and cut the included tissues with a sharp, curved bistoury passed along the groove. Care should be taken to make the cut of the skin and sphincter at right angles to the surface, otherwise a valvular flap is formed, which does not leave a smooth scar in healing. It is important, for fear of incontinence, not to divide the sphincter in more than one place. Consequently, in horseshoe fistulæ and in those with lateral ramifications considerable cutting of the skin must be done without hesitation. In blind external fistula, in which the sinus reaches nearly to the bowel, the director must be forced through and the section completed in the same way; while in blind internal fistula the inner opening must be followed outward and the skin-cut extended to the farthest extremity of the sinus. When the internal opening is high up in the rectum, above the internal sphincter, as in some cases following ischiorectal or pelvirectal abscess, the traumatism is very considerable, and much bleeding may occur. After making the incision the whole sinus should be carefully cleansed, using forcible scraping with Volkmann's spoon in old cases if necessary. Iodoform may then be rubbed in, the whole wound packed with iodoform gauze, and, after inserting a suppository

containing iodoform gr. 10 and morph. sulph. gr. $\frac{1}{2}$, a large, elastic, absorbent dressing should be secured in position by a T-bandage. It is important to see that all bleeding points are secured before the dressings are applied, otherwise troublesome and even dangerous hemorrhage may come on as the heart reacts after the anesthesia.

The prejudice that was formerly felt against operation in tubercular cases does not prevail at the present day, most authorities agreeing that, except in the last stages of phthisis, considerable relief, if not absolute cure, may result from operation.

In long-standing cases, where a very long and fistulous tract with dense fibrous walls exists, the author has had very satisfactory results from the old operation of dissecting out the whole tract and inserting deep sutures, so as to draw the whole of the deep surfaces of the wound together. Much care must be exercised to secure very accurate coaptation at the rectal end of the sinus; and, of course, perfect asepsis is essential to success. When this plan does succeed much time is saved to the patient; but if suppuration occurs the stitches must be removed, and healing must then take place by granulation in the usual way.

Irritable Ulcer and Fissure of the Anus.—These affections are serious and painful out of all proportion to their size, and they are considered together because they are frequently found associated in practice. The condition occurs most frequently in women, though it is not rare in men, and may be found even in very young children.

The *fissure* is usually found just within the anus, extending upward from the junction of the skin and mucous membrane toward the upper part of the anus, and frequently, though by no means always, terminating in a club-shaped extremity that has the appearance of an ulcer. It is generally found between two folds of mucous membrane, and on its lower extremity there is frequently present a small red pile, sometimes known as a "sentinel" pile. It extends merely through the mucous membrane, and, if recent, has a thin red base; but if of long standing, the base may be indurated and thickened. On examination with a probe, frequently there will be found one or two excessively painful spots. These indicate situations in which ulceration has laid bare the sensitive and delicate nerve-filaments which are distributed so freely to the mucous membrane at this part. The fissure is usually single and placed posteriorly; but there may be two or even more distributed around the anal circumference.

The painful, *irritable ulcer* spoken of above really differs but little in its causation and its pathological character from the fissure. It is, however, usually situated at a higher level, just where the anus expands into the ampulla of the rectum. It also usually has a dorsal situation, and is rounded, with slightly indurated base and edges. It is generally very small; but in old cases it may be as large as a sixpence. On examining the ulcer, there is sometimes found a small polypoid growth hanging from the mucous membrane above and pressing against the base of the ulcer.

The origin of these conditions is usually traumatic, being caused by scratching or excoriation of the mucous membrane by hardened feces. Very frequently there is a spasmodic condition of the anus present,

with a hypertrophied, indurated condition of the sphincters. Sometimes there is a congenital narrowing of the anal orifice.

Symptoms.—The most marked symptom is excruciating pain during defecation and persisting for some hours afterward. This is associated with uncontrollable spasm of the sphincter, which adds greatly to the agony of the patient. The pain is of an unusual character, and is felt not only in the anus and perineum, but at the sacro-iliac synchondroses, radiating thence down the inner side and back of the thighs. The feces, if hard, may sometimes be found streaked with blood, and occasionally mucus is passed with the motion, covering its external surface. The pain caused by defecation induces the patient to postpone the act as long as possible, and this leads to constipation, which in turn reacts unfavorably upon the pathological condition. Thus the general health of the patient suffers, and the worrying, pain, and anxiety soon produce a very marked deterioration of health. In women the pains simulate those caused by uterine disease; and in men reflex irritation of the prostate sometimes leads to difficulty of urination and seminal losses.

Treatment.—When the fissure or ulcer is not of long standing and is not kept from healing by mechanical irritation, as from the presence of a small polypus or pile, palliative treatment may result in a cure. The feces must be kept in a soluble condition by means of mild laxatives, as confection of senna, compound licorice powder, etc., and care must be taken to keep the part clean. The local application of an ointment containing cocain may greatly lessen the suffering during defecation. After the act the part should be sponged, and an ointment containing bismuth, extract of belladonna, zinc oxid, and opium or cocain applied.

In more serious or long-standing cases the mild operation introduced by Brodie, of dividing to the extent of $\frac{1}{8}$ inch the muscle-fibers of the sphincter immediately in the base of the ulcer, may be performed under cocain-anesthesia. This will cure the great majority of cases. When the fissures are multiple and indurated, with thickened, hypertrophied sphincters or congenital smallness of the anus, the author is strongly in favor of a systematic dilatation of the sphincter under full anesthesia, after the manner of Récamier. This should not be done in a sudden, forcible manner, but very gradually, by placing the thumbs or fingers within the bowel *upon* the fissures, stretching in one direction and then in another, at the same time kneading the margins of the anus thoroughly. Several minutes should be spent in the operation. If done in this way, no considerable laceration will be produced and no incontinence will result, while by wholly getting rid of the spasmodic action of the sphincter such rest is obtained that the fissures heal rapidly. A suppository containing $\frac{1}{2}$ grain of morphin and 5 grains of iodoform should then be inserted. Where the induration is very great advantage is gained by scraping thoroughly with Volkmann's spoon, or even resorting to excision of the whole diseased area.

Hemorrhoids.—The arterial supply of the upper part of the rectum is derived through the superior hemorrhoidal artery from the inferior mesenteric, while that to the middle and lower portions comes from the branches of the internal iliac. The arteries perforate the muscular coats at various levels, and on reaching the submucous area pass

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in a more or less parallel longitudinal direction toward the anus. Their lateral communications are free, while near the anus they inosculate to form a very rich vascular plexus. The veins arising therefrom form a very complex interlacement just within the anus (called the hemorrhoidal plexus), pursue a similar longitudinal course, and pass at various levels through buttonhole-like openings in the muscular walls, the lower ones reaching the systemic venous circulation as the inferior and middle hemorrhoidal veins, while the upper ones, as the superior hemorrhoidal, empty into the inferior mesenteric vein, and so reach the portal circulation. This remote connection of these valveless veins with the portal system undoubtedly explains the effect of derangement of the liver in producing attacks of piles. Even in healthy conditions the veins, being unprovided with valves, are severely taxed to maintain the weight of the long column of blood reaching to the liver, while any obstruction in that organ adds enormously to the tension to which their walls are subjected. The erect posture of the human body is unquestionably also a reason why hemorrhoids are so extremely common in man, while almost unknown among the lower animals, in which the rectum has a horizontal direction.

Etiology.—Hemorrhoids, or piles, have their origin in a diseased or weakened condition of the veins at the lower end of the rectum. These vessels become dilated and varicose, and at the same time increase in length; but these conditions may be present for a considerable time without giving rise to any very well-marked symptoms. An "attack of piles" occurs, however, when a phlebitis is induced in these unhealthy veins as the result of constipation, exposure to wet and cold, prolonged violent exercise, overindulgence in eating, drinking, or smoking, and other similar causes. When inflammation occurs in the walls of the vein, the vessel loses its tone, its muscular walls become paralyzed, and it becomes greatly dilated at certain points. Thrombosis then occurs, usually at the lower part first; but the clotting may extend into the longitudinal veins in the columns of Morgagni above the sphincter. This condition is, of course, exceedingly painful, and gives rise to the classic symptoms of hemorrhoids, which will be given presently. It must not be understood, however, that a pile is merely the inflammation and dilatation of one vein. Usually in a single pile there is a congeries of varicose veins—some more dilated than others—together with increased arterial supply and proliferation and edema of the connective tissue of the submucous coat. Thus a pile is a real tumor, whose formation depends upon the initial disease in the veins. In old and neglected cases, indeed, the venous character of the tumor ceases to be a prominent feature, and the mass becomes a fibrosed and indurated tumor of submucous tissue covered partly with skin and partly with mucous membrane. These are sometimes called "fleshy piles."

Classification.—The time-honored division of piles into those mainly outside the grasp of the sphincter muscles—*external piles* (Fig. 277, *b*)— and those mainly within the bowel—*internal piles* (Fig. 277, *a*)—cannot, for clinical purposes at least, be improved upon. In internal piles, covered as they are with a delicate mucous membrane which under irritation becomes highly vascular or ulcerated, bleeding is a very constant symptom, and this feature has led to their being characterized as "bleed-

ing " piles, to distinguish them from the non-bleeding or " blind " tumors of the better protected external variety.

An external pile is frequently found to be directly continuous with, or to be divided by a very shallow sulcus from, an internal one. Such may be properly designated *interno-external* piles (Fig. 277, *c*).

External hemorrhoids are tumors of varying size, covered by cutaneous or mucocutaneous tissue, and situated below the grasp of the external sphincter. When in a quiescent state they form radiating folds around the anus and may be quite painless; but when, under irritation or as the result of obstruction in the portal circulation, they become inflamed, these soft, flaccid folds are converted into tense, edematous, and exceedingly painful tumors. The veins in these piles empty into the systemic circulation through the inferior hemorrhoidal; but so intimate is the anastomosis between these and the radicles of the superior
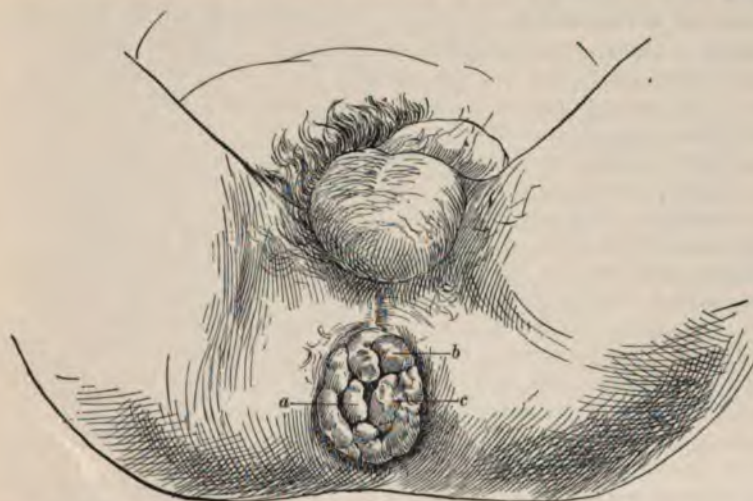
FIG. 277.—Prolapsed interno-external hemorrhoids: *a*, internal; *b*, external; *c*, interno-external pile.

hemorrhoidal that any condition of the portal circulation which will act as a cause of internal piles is capable of becoming an etiological factor also in relation to the external variety.

Symptoms.—If of considerable size, even in a quiescent state, external piles are accompanied by a sense of weight, dragging, and itching; but when phlebitis supervenes the suffering becomes very acute. The pain is of a throbbing, aching character, is deep-seated, and may radiate up the rectum, along the perineum, and into the back or thighs. It is aggravated by walking, or by movements of the diaphragm, such as in sneezing or coughing. Defecation may be very painful, and may excite a spasmodic contraction of the sphincter which will continue for some hours. Suppuration sometimes ensues, with thrombosis of the blood in the veins. In this way a spontaneous cure is sometimes achieved, though not without much suffering.

Treatment.—An inflamed external pile may be greatly soothed by

the application of equal parts of extract of belladonna and glycerin, followed by hot fomentations. If a large thrombus form in a vein, it should be freely incised and the clot turned out. Abscess, of course, calls for prompt incision and drainage, and care should be taken to avoid the formation of a fistula. Of the many methods employed in the radical treatment of piles, excision is the only one widely practised upon the external variety. If the operation is extensive, general anesthesia should be employed; if not, cocain, either injected or applied externally, may be used. Seizing the little tumor with a pair of catch-forceps, it is clipped away with scissors. Too little rather than too much should be removed, as stricture is liable to follow a too free removal of the skin. The cuts should radiate toward the anus; and if much bleeding occur or a very large wound be left, a stitch or two may be inserted. After applying a little iodoform, a pad of gauze is placed over the wound and secured by a T-bandage.

Internal hemorrhoids are those situated entirely within the verge of the anus. These are elongated or globular in shape, usually sessile upon a broad base, and extend upward for 1 inch or more within the anus. They are spongy and elastic to the feel, and differ so slightly in consistence from the normal columns of the rectum that they may escape detection by the finger of the uninitiated during rectal examination. When examined through a speculum, however, or when " down " after defecation, they are seen to be of a dusky-red color that contrasts strongly with the pink color of the healthy mucous membrane. The membrane between the piles is often thrown into horizontal folds, which are stretched or torn by the hardened feces, giving rise to fissures; or perhaps prolapse of the whole ring of mucous membrane may occur from the dragging action of the feces during expulsion. The globular variety is frequently the seat of a superficial ulceration with a granular base, in which arterial vessels of considerable size ramify. This is the " bleeding " pile *par excellence*, the blood being of a florid, arterial hue, and the amount being in some cases excessive.

Symptoms.—In addition to the heat, itching, and smarting about the anus which are also felt in external piles, internal piles when severe are accompanied by a symptom due almost entirely to their bulk. This symptom is a sensation of fulness and distention in the rectum, as if containing a foreign body. During the act of defecation the congestion of the piles is increased, and as they are carried downward within the grasp of the sphincter the desire for expulsion develops into a tenesmus which is associated with a peculiar feeling of sickness and distress. The tenesmus, of course, greatly aggravates the symptoms, and when the sphincters are hypertrophied and irritable their spasmodic contraction upon the prolapsed piles produces an agonizing pain, the daily repetition of which quickly exhausts the patient. After each act of defecation the patient is under the necessity of replacing the piles by pressure from without, and it is only by the exercise of great self-control that he can prevent the rectum from again attempting to get rid of its own excrescences. In relaxed subjects the piles escape from the weakened sphincters not only during defecation, but also during coughing, sneezing, and stooping, and in old-standing cases they remain permanently prolapsed. Much discomfort also results from the escape from the

anus of an acrid and irritating mucus, which keeps the perineum moist, often causes excoriation, and favors the growth of warty excrescences. Sooner or later external piles develop in connection with a greater or less prolapse of the whole mucous membrane. Pains are now felt in the lumbar region and down the thighs as well as in the perineum. Irritability of the bladder and testicles or of the uterus may be present, and the patient's health deteriorates. A careworn, apprehensive countenance, with great anemia and emaciation, are symptoms of an advanced stage of the malady.

The amount of blood lost varies widely in different cases. Sometimes there is merely a slight streaking of the feces on one side, whereas in other cases the loss may be estimated in pints. In females a hemorrhoidal flux sometimes replaces the menstrual flow, and in apoplectic individuals with cirrhotic livers and calcified arteries the judicious surgeon will hesitate to stop a discharge from bleeding piles, lest the tension of the overloaded vascular system should prove too great for the weakened cerebral vessels and an apoplexy result.

Treatment.—Though much may be done to *palliate* the symptoms of internal piles, it is but seldom that anything short of a radical operation will result in a cure. Removing the cause of the malady so far as is possible is always a rational measure. Hence, debilitated subjects must be nourished and strengthened; the plethoric should be depleted and restrained in their diet; constipation must be overcome by mild laxatives, whereas drastic purgatives should be sedulously avoided.

Local palliative measures consist in sponging night and morning with cold water, applying extract of belladonna and glycerin, equal parts, and hot fomentations when the piles are down and cannot be returned, and using astringent injections or ointments in those cases which refuse operation. When the piles are strangulated by being grasped by the sphincter they should be sponged with cold water for a few minutes, then well oiled, and returned by steady pressure. Frequently by passing one finger into the lumen as a guide and pressing the piles back one at a time the whole may be easily reduced.

Operative Measures.—The operations most in favor at the present time are: 1. Removal by ligature; 2. Clamp and cautery; 3. Excision of the pile-bearing area by Whitehead's method.

Other procedures which are still used by some, but which are much less to be recommended and which will not further be considered are: 1. Application of caustics to the surface; 2. Injection of coagulating fluids into the interior; 3. Electrolysis; 4. Crushing.

A useful prelude to all the recognized operations is a complete and thorough dilatation of the sphincters as described under the treatment of Fissures. This should be systematically done, not hurriedly or forcibly, but with care, to avoid tearing the mucous membrane, and to produce a stretching rather than a rupture of the sphincters. A purgative should be given the day before, and the bowel well emptied by enema an hour or two before the operation.

Ligature.—This method is without question the one most generally applicable. It is safe, efficient, easy to perform, and seldom followed by unpleasant symptoms. The mode of operating is briefly as follows: The pile is seized with a pair of spring-forceps and slightly raised. With

a pair of scissors an incision is then commenced at the junction of the skin and mucous membrane below, continued across the lower confines of the tumor and upward on each side, the separation being continued through the submucous tissue until the pile is merely hanging by a narrow pedicle which contains both the artery and veins. A ligature is then tied *very tightly* around the pedicle, the bulk of the pile is clipped away with scissors, and the ends of the ligature cut short. Each pile, large or small, is treated in the same way ; and it is better to commence with those most dependent, so that the escaping blood will not interfere with the view.

Clamp and Cautery.—After dilating the sphincter the piles are seized in succession and drawn well up within the grasp of the clamp. The latter must be screwed up very tightly, otherwise it is apt to slip when the pile is cut away. The bulk of the pile is then removed with scissors, and its base thoroughly seared with the cautery at a dull-red heat.

Whitehead's Operation.—The patient is placed in the lithotomy-position, the sphincter dilated, and the piles encouraged to come down. Then with scissors the *mucous membrane* is divided at its junction with the skin around the entire circumference of the bowel. By rapid dissection with blunt-pointed scissors or the finger, the whole ring is then stripped from its submucous bed, so that the mucous membrane with its attached hemorrhoids may be pulled bodily down. The mucous membrane above the hemorrhoids is then divided transversely in successive stages, and the free margin of the severed membrane above is attached, as soon as divided, to the free margin of the skin below by a suitable number of sutures. The complete ring of pile-bearing mucous membrane is thus removed. Any bleeding vessels may be twisted or a stitch made to include them. Iodoform is rubbed in, a suppository containing 2 grains of extract of belladonna (Whitehead) or $\frac{1}{4}$ to $\frac{1}{2}$ grain of morphin inserted, and a pad and bandage applied. Healing will generally take place by first intention.

Notwithstanding the sweeping condemnation of this operation by some of its opponents, the opinion is here expressed that, *if done precisely as Whitehead recommends*, no better operation can be devised for those cases in which the whole ring of mucous membrane is affected with piles. If the fatal mistake is made of cutting through the skin at the sulcus where the skin of the nates and perineum begins to rise over the pile, instead of through the mucous membrane at its junction with the skin, a most deplorable and irremediable condition results. The mucous membrane is thus drawn down and exposed, and constantly weeps an acrid, irritating mucus. Moreover, there is likely to be incontinence of flatus and liquid stools. This lamentable result, however, is not due to the operation, but to a *misconception* of the operation as described by its originator.

Prolapsus Ani.—The term prolapsus ani refers to a condition in which a relaxed anal mucous membrane descends through the anal orifice and remains either temporarily or permanently outside the sphincters. This prolapse is associated with an elongated and thickened submucous tissue, but the muscular coats of the rectum maintain their healthy relations. It occurs but rarely in children, in whom pro-

cidentia recti is more common; but it is not an uncommon malady in adults. The subjects of prolapsus are usually those with relaxed tissue; but the exciting cause is generally some mechanical condition which induces straining and tenesmus, such as tight stricture, stone in the bladder, or severe chronic constipation. It may also occur during an attack of diarrhea or dysentery, or may be a complication of internal hemorrhoids. Prolapsus is distinguished from the protrusion of an intussusception by the fact that in the former the continuity of the skin with the prolapsed mucous membrane is quite apparent, whereas in the latter the finger may be passed into a distinct sulcus between the two in the entire circumference of the protrusion. This sulcus may be deeper than the length of the finger. There is usually a slight or copious secretion of mucus from the protruded membrane, and sometimes ulceration and bleeding are troublesome. Where the protrusion is large and the sphincters active, strangulation and sloughing may occur. This may bring about a spontaneous cure.

Treatment.—As prolapse is in reality a symptom and not a disease in itself, it is obvious that the removal of the cause is the most important feature in the treatment. Hence, attention should be directed to the removal of stone, stricture, or polypus; to the cure of diarrhea, dysentery, or constipation; and to the building up of a relaxed constitution. When the subject is a child, pinworms and phimosis are to be looked for and removed, if present. The child's manner of defecation must be controlled. Straining on the chamber must not be allowed, but the motions must be passed either in the recumbent or erect posture, while one buttock is drawn strongly to the side in order to render the anal orifice tense. The buttocks may then be held together by strips of adhesive plaster until the time of the next motion of the bowels. When, in spite of precautions, the bowel protrudes during defecation, either in the child or adult, it is highly important to reduce it immediately. It should be carefully sponged with cold water, and then with a solution of alum, tannic acid, carbolic acid, or solution of iron; then, being well anointed with olive oil or vaselin, it is gently and carefully returned. More radical measures will be considered when speaking of procidentia recti.

Procidentia Recti.—This term indicates the protrusion from the anus of an annular mass which includes the whole of the coats of the rectum (Fig. 278). It occurs most frequently in children, being in them much more common than the former condition; but it also occurs in elderly men, and in women who have borne many children and whose pelvic structures have been dam-

FIG. 278.—Procidentia of the rectum, protruding 6 inches.

aged in the process. An anatomical reason for its greater frequency among children is the fact that the sacrum in early life is much more

upright and less curved than in adults, and thus furnishes less support to the rectum.

In children the mass protrudes as an almost straight column. In the case of a child aged two and one-half years, under the care of the writer, the apex of the conical mass was about 8 inches from the anal orifice; but in adults the tendency is for the prolapsed rectum to accumulate in a rounded mass in the vicinity of the anus, where it may form a tumor as large as a child's head.

Treatment.—In most cases the treatment recommended in the treatment of prolapse will bring about a cure of the procidentia recti of
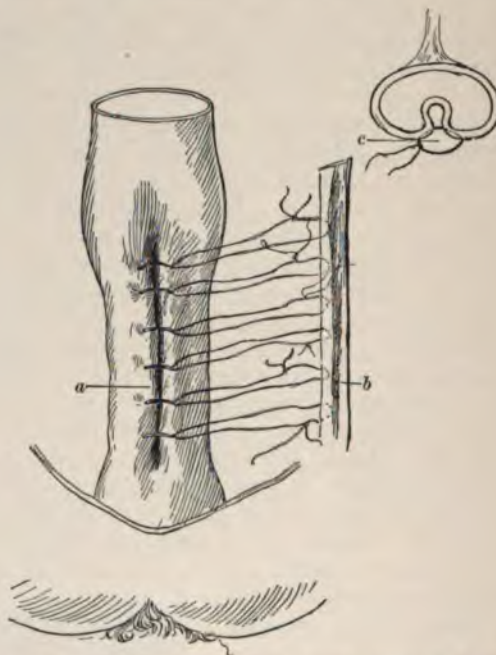
FIG. 279.—Illustrating the author's method of dealing with intractable procidentia recti (rectopexy): *a*, dilated portion of rectum with anterior surface unfolded; *b*, section of abdominal wall, to which rectum is drawn by tightening the sutures; *c*, method of infolding and introducing sutures.

children—viz., removal of the cause, and prevention of the protrusion during defecation. In severe cases it is advisable to keep the child in the recumbent posture and support the buttocks by the hand after defecation until all tenesmus and straining efforts cease.

When these prophylactic and palliative measures fail, among the many more radical procedures that have been adopted by various surgeons the following may be recommended:

1. The application, under anesthesia, of fuming nitric acid or acid mercuric nitrate to the whole of the exposed mucous membrane. Allingham states that stricture has followed in some cases, and dangerous sloughing and hemorrhage in others; but frequently a cure is effected without the occurrence of any alarming symptoms.

2. Van Buren was the first to recommend the use of the actual cautery. The patient being anesthetized, the procidentia is fully drawn down, and with the cautery at a dull-red heat, from 4 to 6 longitudinal stripes are made from the base to the apex of the protrusion. Care is taken not to make the burns at the apex deep enough to injure the peritoneum; but at the base the iron should be sunk, with a sawing motion, deeply into the sphincter, if this muscle appears too much relaxed. When the wounds are healed the contraction of the scars in a longitudinal direction tends to shorten the rectum, while there is also a diminution in its circumference, due to the same cause.

3. In a very severe case of a child two and one-half years of age, in which the procidentia protruded 8 inches, and in which there were also ectopia vesicæ and congenital absence of the pubic arch, the writer obtained a completely successful result by the following operation, which, he believes, is here described for the first time:

The abdomen was opened in the middle line, and the procidentia reduced with great ease by drawing up the rectum from within the abdomen. The next step was to procure a narrowing of the lumen of the gut at its lowest part by folding in its anterior wall and inserting stitches in such a way as to retain the fold (Fig. 279, *a* and *c*). Six silk stitches were inserted and made to include a goodly portion of the serous and muscular coats (Fig. 279, *c*). The lowest stitch was placed as low down toward the anus as it was possible to reach. In this way the wide part of the prolapsed bowel (the intussuscipiens) was narrowed so as to abolish to a great extent the tendency of the part above (the intussusceptum) to drop into it. In order still further to prevent the tendency to prolapse, one end of each of these sutures was passed into the parietal peritoneum and abdominal wall (Fig. 279, *b*) as far upward and outward toward the left iliac fossa as possible, and then tied to the other end in such a manner as to keep the rectum from prolapsing. The term " rectopexy " would be an appropriate one to apply to this procedure. It is now two years since the operation was done, and there is at present no sign of recurrence.

4. Other radical measures that may be mentioned are removal of the whole prolapsed mass (Treves), removal of a triangular section from the posterior aspect of the bowel (Roberts), and stitching the rectum to the region of the coccyx and sacrum (Verneuil), or to the abdominal wall (MacLeod), and attaching the mesentery to the abdominal wall (Allingham).

Polypus.—Polypus of the rectum is a pedunculated tumor of variable size, usually formed by the gradual pedunculation of a benign neoplasm, such as an adenoma, papilloma, fibroma, or, as Ball claims, by the stretching of the base of a fibrosed internal pile.

They are most frequently found in young children, and give rise to tenesmus, frequent defecation, and discharge of mucus. In the papillomatous form hemorrhage may be a frequent and even dangerous symptom.

The **diagnosis** is not difficult, the mass being easily distinguished from intussusception and internal piles. The papilloma is distinguished from cancer by its slower growth, softer consistence, the age of the patient, and the fact that it does not infiltrate the deeper tissues.

Treatment.—The tumor must be removed by twisting through the pedicle if small and near the anus, or by ligature if long and situated high up.

Ulceration of the rectum may be—1. Simple; 2. Syphilitic; 3. Tuberculous; 4. Malignant.

Simple Ulceration.—Solitary simple ulcer has been described under the heading of Irritable Ulcer and Fissure. Generalized ulceration of a simple character occurs in chronic diarrhea and dysentery. It appears to commence in the follicles, and gives rise to the secretion of a large amount of mucus and to frequent small hemorrhages. When of long standing, a fibrosis of the submucous and muscular coats occurs, the steady contraction of which causes the formation of simple stricture. Occasionally, undermining of the mucous coat occurs, and when healing is completed certain bridge-like processes are left, under which a pin or bristle may be passed (Fig. 280). In very chronic cases the intervening mucous membrane may present a "shaven-beard" appearance, due to chronic congestion with minute extravasations of blood into the mucous membrane.

FIG. 280.—Simple ulceration of the rectum: a, healthy anus; b, ulcerated and congested mucous membrane, with pins passed under bridges of mucous membrane; c, healed portion, showing pigmentation.

The *treatment* of this condition is eminently unsatisfactory. Sometimes benefit is derived from rest in bed and a milk-diet, with measures to keep the large bowel free from irritation of constipated motions on the one hand, and decomposing liquid stools on the other. To this end the use of saline mineral waters is adapted, and the rectum may be washed out night and morning with warm water in which a small amount of boric acid is dissolved. As an occasional more stimulating wash, silver nitrate, 2 to 5 grains to the ounce, may be used. When the ulceration is near the anus, an ointment containing boric acid or bismuth and iodoform may be introduced with advantage by means of Allingham's screw ointment-introducer.

Syphilitic ulceration is generally confined to the lower portion of the rectum. It is met with chiefly in young women, and is but rarely seen in men. It appears to be usually a tertiary lesion, and results from the breaking down of submucous granulomata. These ulcers are exceedingly intractable, give rise to great pain, and lead to the formation of extensive cicatricial contraction of the bowel. In addition to the measures used in treating simple ulceration of the bowel, constitutional treatment is highly important, the iodids particularly requiring to be pushed to the physiological limit. Locally iodoform gives the most satisfactory results; a bougie containing 4 or 5 grains of iodoform and from $\frac{1}{16}$ to $\frac{1}{12}$ grain of mercuric chlorid being introduced after the morning motion. Ultimately a colotomy may be required, on account

of the cicatricial contraction or to relieve the patient of the irritation of the feces passing over the ulcer.

Tuberculous ulceration is not frequently met with; but when present it has a tendency to perforate the whole thickness of the bowel-wall, thus giving rise to fistula. The treatment consists in dividing the fistula—when the constitutional condition of the patient will justify that operation—scraping the ulcers thoroughly with Volkmann's spoon, and dressing with iodoform.

Stricture of the Rectum.—Contraction of the lumen of the rectum may be a sequel of simple inflammatory processes or sloughing—simple stricture; it may be due to syphilis; or to the growth of a cancerous mass in the walls of the gut—malignant stricture.

Simple or *fibrous stricture* occurs generally in elderly people, and more often among females than among males, the reason for its greater frequency in women being, no doubt, connected with the childbearing function. Sloughing of portions of the rectal wall from pressure of the fetal head is apt to be followed by stricture, and pelvic inflammation may cause stricture by the cicatricial tissue quite outside the bowel. Congenital stricture, due to imperfect absorption of the septum between the stomodeum and the enterodeum, occurs as a very rare condition.

The **symptoms** are straining and difficulty in defecation, with a discharge of mucus or blood if ulceration is present. If near the anus, the stricture may cause the feces to pass in pipe-stem or ribbon-like forms, but more frequently the stools are passed in short, broken fragments. Diarrhea often alternates with constipation.

Treatment.—When no ulceration is present, the daily use of flexible bougies is to be recommended. Great gentleness is to be used, as the injudicious use of even a soft bougie in a stricture high up may induce ulceration or even perforation of the bowel with fatal peritonitis. In the case of annular strictures low down, limited division by a knife, followed by the use of bougies, may be employed. In very severe forms with ulceration and fistula linear rectotomy in a backward direction, as recommended by Verneuil, affords the only hope of cure. The incision should be made directly in the middle line, and must extend from above the stricture through all the soft parts, including both sphincters, to the tip of the coccyx. In strictures which prove quite incurable colotomy must be done. Syphilitic stricture occurs as the result of syphilitic ulceration described above, and is generally within reach of the finger. It is in most cases accompanied by ulceration, and excruciating pain is an almost constant symptom. It is practically incurable, and where linear proctotomy fails to give relief, colotomy must be done.

Benign tumors of the rectum are not common. Those most frequently found are fibroma, papilloma, and adenoma. Papillomata sometimes attain enormous dimensions (Fig. 281) and are apt to undergo malignant transformation into carcinomata.

The **treatment** consists in early and complete removal in every case.

Carcinoma of the Anus.—When malignant disease affects the anus, it almost invariably assumes the type of the squamous-cell epithelioma. It forms a nodular, slow-growing mass, and may be mistaken by the patient for an external pile. Sooner or later it ulcerates upon the surface, while its deeper part infiltrates the adjacent tissue.

The only **treatment** of any avail is free removal before the sacral glands become involved. When the tumor spreads upon the perineum, secondary growths may be found in the inguinal glands.

FIG. 281.—Papilloma of the rectum causing obstruction: *a*, anus; *b*, dilated rectum above neoplasm. This tumor ultimately became carcinomatous.

Carcinoma of the Rectum.—The type of neoplasm here is almost without exception the columnar-cell epithelioma (Fig. 283), or adenomatous carcinoma. Glandular carcinoma—viz., scirrhous or

FIG. 282.—Non-malignant papilloma of the anus.

encephaloid—is not unknown; while colloid degeneration of a columnar epithelioma, such as that figured in Fig. 283, is a somewhat rare condition.

Carcinomatous disease of the rectum rarely begins lower down than from 3 to 5 inches above the anus (Fig. 283, *a*), and its tendency is to spread upward in the direction of the blood-supply and lymph-vessels. It is found with about equal frequency in both sexes, but a notable feature is its tendency to appear much earlier in life than it is usual for carcinoma to appear in other parts of the body. The writer has seen 2 cases under the age of twenty-one years; and Allingham mentions having encountered carcinoma in youths of thirteen and seventeen years.

Columnar carcinoma varies considerably in its clinical characters in different individuals. Where the constructive metabolism is greater than the destructive ulceration, the growth may project as a hard, nodular mass into the lumen of the bowel. In some such cases it appears to be almost pedunculated; in others it remains freely movable, though extending almost entirely around the circumference of the bowel. Stricture and obstruction to the passage of the feces may occur from two causes: (1) From the filling up of the lumen of the bowel by the nodular growths of the neoplasm, or (2) from contraction of the cicatricial tissue in the base of the growth, where it has assumed the annular form, embracing the whole circumference of the b o w e l. Commencing in the mucous membrane, the tendency of the growth is to spread deeply, so as to involve successively all the coats of the intestine, then the adjacent areolar tissue, and finally to infiltrate adjacent organs and tissues, such as the vagina, uterus or bladder, pelvic bones, etc. Ulceration leading to most distressing fistulæ often takes place between the rectum and bladder or vagina.

FIG. 283.—Columnar-cell epithelioma with colloid degeneration: *a*, healthy anus; *b*, urethra pressed upon by growth; *c*, bladder-wall, greatly hypertrophied; *d*, artificial anus at upper limits of the sigmoid. (Same case as Fig. 285.)

Symptoms.—In the majority of cases of cancer of the rectum the onset is so insidious that they do not come under the care of the surgeon until the disease is so far advanced as to render removal impossible. Among the earliest and most constant symptoms may be mentioned the passage, in small quantities, of blood and mucus, a sense of unrest in the pelvis, and a tendency to diarrhea. Constipation alternating with diarrhea is a most suggestive symptom. When ulceration has set in, the act of defecation is accompanied by great pain and a discharge of blood and mucus, and a feeling is left as if the bowel had not completely emptied itself. In the later stages cachexia becomes marked, and the patient becomes emaciated and careworn from pain, loss of sleep, and failure of nutrition. Secondary growths, hemorrhages, and fistulous openings hasten the fatal issue.

The duration of life varies greatly in different cases. The cancer appears to grow more luxuriantly in the young and full-blooded, in whom death may occur in from one to two years. In those advanced in years life may be prolonged from five to eight years.

Treatment.—In the vast majority of cases the treatment of cancer of the rectum is of necessity restricted to palliative measures. The following are the conditions favorable for removal as given by Harrison Cripps: The patient must not be too old; he must be in fair health; the growth must be freely movable, and its upper limits must be within reach of the finger. Implication of the lymphatic glands or neighboring organs is a contra-indication, and the most favorable cases are those in which the growth is limited to the posterior aspect of the bowel. According to Cripps, only 1 case in 5 that come under observation fulfils these requirements, and other authors give even a smaller percentage. In regard to the question of age, Allingham is opposed to excision in patients under the age of forty-five years, and regards the period between forty-five and sixty years as favorable to excision, but not so much so as in patients over sixty years of age. By the use of Kraske's operation, cancers situated higher up than those included in Cripps's limitations have been successfully excised. The mortality from the operation in the hands of skilful operators is still high, varying from 12 to 20 per cent., but has decreased steadily as knowledge of the technic has improved. The duration of life in cases allowed to run their natural course varies widely. Ball gives the average life after the first appearance of symptoms as about two years; but when the tumor commences late in life the fatal issue may be delayed at least five or six years.

The question of the probability of permanent cure after excision is still an open one, and depends upon the period at which the operation is done, not less than upon the boldness and skill of the operator. In an early case presenting the features favorable to excision, the surgeon may with propriety urge the operation; but in more advanced stages of the disease, one's plain duty is to place before his patient the salient facts of the case, not disguising the somewhat gloomy prognosis in cases calling for extensive operation, but at the same time acquainting him with the still more gloomy future of perpetual pain and annoyance to which he must look forward should he elect not to be operated upon.

Excision of the Rectum.—*The Perineal Operation.*—According to Harrison Cripps, one of the chief exponents of this operation, no attempt should be made to remove tumors by this route which are not within 4 inches of the anus; and in women the growth must not have affected the anterior wall further up the bowel than 3 inches. He considers that when the disease affects the anterior wall of the bowel, the vagina and the uterus become implicated much earlier than the prostate and bladder of the male.

If the anus and the mucous membrane covering the internal sphincter are free from disease—which is rarely the case when the disease is so low down—an attempt should be made to preserve the natural outlet, thus giving some hope of retaining continence of feces and greatly lessening the danger of stricture. The operation is briefly as follows:

A deep incision is first made from the anus to the coccyx. A circular incision is then made about 1 inch away from the extreme limits of the growth. This incision, according

to the extent of the growth, may require to be in the skin around the anus, or may be through the coats of the bowel above the internal sphincter. The bowel is then readily separated from its posterior and lateral attachments by blunt dissection, the finger or blunt-pointed scissors being used. In the male the situation of the urethra is made evident by the introduction of a full-sized sound, and in the female valuable aid is given by a finger occasionally inserted into the vagina. Should the rectovaginal septum be involved, it must be freely removed, and an attempt made to repair the fistula subsequently. The proximity of the peritoneum and the fact that it may be dragged down by the growth must not be lost sight of; and if opened accidentally or of necessity, it must be either very carefully stitched up or very thoroughly drained. Having carried the dissection up well beyond the limits of the tumor, the whole mass is drawn down as far as possible, and by means of scissors a circular incision is made about 1 inch above the highest infected area. Before cutting the bowel across it should be seized by vulsellum forceps, in order to prevent its retracting out of reach, a contingency which adds greatly to the difficulty of controlling hemorrhage. The ultimate disposal of the upper end of the resected bowel will depend upon how far it can be drawn down. The ideal operation would be to stitch it to the lower section above the sphincters;

FIG. 284.—Malignant disease of the rectum commencing as a papilloma perforating the sacrum. A colostomy was done to afford exit for the feces.

but, of course, this is not always possible. Authorities are divided as to whether it should be allowed to remain at the upper portion of the wound or whether an attempt should be made to stitch it to the skin, it being held that in the former case stricture is apt to result, and in the latter that the sutures are liable to cut out, and drainage being interfered with sepsis may result. Each case must therefore be treated according to the exigencies of the occasion and the discretion of the operator.

Kraske's Operation.—This operation is adapted to those cases in which the disease is above the limits prescribed by Cripps. The patient being placed upon the right side, an incision is made from the middle of the sacrum to the verge of the anus, and a flap including the gluteus maximus and the sacro-iliac ligaments is turned to the left. The lateral mass of the sacrum below the third posterior foramen and the whole of the coccyx are then removed, and through the opening thus made the rectum is brought finally into view. The peritoneum is now deliberately opened, and the rectum completely isolated. Before dividing the gut above and below the tumor the wound should be carefully protected by gauze, and the escape of feces into it checked, as far as possible, by the use of intestinal clamps or temporary ligatures of gauze. Much of the success of the operation depends upon the effectiveness of these measures to prevent sepsis. The delicate point as to what to do with the upper end of the gut must now be decided. If an end-to-end anastomosis seems feasible—which is rarely the case—the attempt should be made. In other cases the interests of the patient will be best served by bringing the upper end out at the posterior wound and stitching it to the skin in that position.

The operation is undoubtedly a very severe one, attended by much shock and hemorrhage, and the technical difficulties are so great that it should be attempted by those only who are possessed of considerable surgical skill and experience.

There are certain cases unsuitable for excision, in which the amount of stricture is so great as to give rise to the symptoms of obstruction. Such cases are usually associated with a great deal of pain and distress.

Relief is therefore urgently called for by some surgical measure, and the choice lies between (1) linear proctotomy, (2) gouging out the fungating mass, and (3) colotomy.

Linear proctotomy consists in making a cut backward toward the sacrum and coccyx, from the healthy tissue above the stricture, quite through the diseased mass, and including both sphincters, whether diseased or not. This operation is a safe one, and is effectual in affording at least temporary relief. The hemorrhage may be controlled by catching and tying the main vessels, or by stuffing the whole wound-area for a few hours with iodoform gauze. This measure may be combined with the following:

Gouging out the diseased tissue may be done by means of a Volkmann's spoon or, where the growth is soft, by the fingers. It is suitable for those cases with exuberant fungations, frequent profuse hemorrhages, and foul, septic discharges. The operation must be done thoroughly and rapidly, the curetting being continued until a firm base is reached.

Colotomy.—The various operations of colotomy will be found to be

FIG. 285.—Inguinal colotomy by Maydl-Reclus operation for columnar-cell epithelioma. The growth had so pressed upon the urethra as to necessitate a suprapubic cystotomy. *a*, longitudinal incision in loop of sigmoid; *b*, gutta-percha rod passed through mesentery; *c*, tube draining bladder. (Same case as Fig. 283.)

fully described in Chapter XII. of this volume, and it will be sufficient here simply to discuss when colotomy should be done in cases of cancer of the rectum. As a palliative measure in cases of obstruction associated with spurious diarrhea and great pain or the formation of fistulæ into the bladder, vagina, or upon the perineum, colotomy affords a means of giving very great relief to the patient. The lessening of the rate of growth claimed by some authorities is strongly disallowed by Allingham, and it must be borne in mind that the artificial anus in either the inguinal or lumbar region is very frequently a source of annoyance and embarrassment to the patient. Accordingly, when a patient is able to pass feces without great pain, and when careful palliative treatment enables him to live in tolerable comfort, colotomy should not be done, but should be held in reserve to be applied on the occurrence of obstruction or the formation of fistulæ. In cases thus carefully selected colotomy

may properly be looked upon as a means of prolonging life for a few months at least, and of greatly ameliorating the sufferings of the patient's last days.

When the symptoms of obstruction are not urgent, the operation known as the Reclus-Maydl operation is the simplest and best. It consists briefly in making a parietal incision just above the anterior superior spine of the ilium on the left side, seizing the sigmoid, drawing it through the wound, and passing a glass or gutta-percha rod through the meso-colon close to the intestine (Fig. 285, *b*). Care should be taken to draw down the sigmoid so that its upper part (Fig. 283, *d*) is brought into the wound, otherwise troublesome prolapse may occur. No sutures are required, the operation occupies but a few minutes, and there is consequently but little shock. The gut may be opened with safety in three or four days.

The question of the administration of opium and its alkaloids is a most important one, and resolves itself into a choice of evils. When the sufferings of the patient become excessive, the administration of the opium affords a merciful relief; but in a slow-growing tumor the danger of establishing by the use of the drug an inability to bear the least physical pain and a mental condition but little less distressing than the disease itself, should make the surgeon cautious to commence this means of relief as late as possible, and to give the drug in the smallest possible quantities.

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CHAPTER XVII.

SURGERY OF THE PENIS, URETHRA, PROSTATE, AND BLADDER.

SURGERY OF THE PENIS.

THE **congenital malformations** of the penis are phimosis and the various forms of hypospadias and epispadias.

Hypospadias is a condition in which there is an absence of some part of the floor of the urethra. Most often the urethral opening is in the neighborhood of the glans, when it is called *balanitic hypospadias*. The opening may be in the perineum—the *penoscrotal* form of hypospadias. In this form the whole floor of the perineal urethra may be wanting, and in many such cases some degree of arrested development of the scrotum and testicles is present—many cases diagnosed as hermaphrodism are only extreme forms of penoscrotal hypospadias. The ability to procreate depends on the site of the urethral opening. *Perineoscrotal* hypospadias is the result of a still earlier arrest of development.

Treatment.—Operations for the cure of balanitic or penile hypospadias are seldom successful. The method devised by Duplay is the best. This operation must be done in three stages, with a delay of weeks or months between each stage. The steps of this operation are as follows: 1. Straightening the penis by transverse cuts. 2. Forming a new urethra and restoring the meatus, and suturing skin-flaps from the lateral regions of the penis over a catheter left in the new-formed urethral canal. 3. Closing the abnormal opening.

Epispadias is a congenital absence of some portion of the roof of the urethra. It is much rarer than hypospadias, and is in many cases associated with exstrophy of the bladder. Operations for this condition have been even less successful than for hypospadias.

Phimosis, a condition in which the prepuce cannot be retracted over the glans penis, may be congenital or may be caused by inflammatory states, gonorrhea, chancroids, etc. As seen in children, the prepuce is sometimes much elongated, with a greatly contracted orifice—the "pinhole prepuce." Relief of this condition is important, for the irritation of retained secretions causes various reflex nervous troubles, and the straining during urination may cause hernia. In adults a persisting phimosis favors the contraction of venereal disease and predisposes to epithelioma. All cases of phimosis should be operated upon.

Circumcision.—This operation is best done under general anesthesia. In adults cocain may be used, but it is liable to cause annoying edema of the tissues. After the prepuce has been thoroughly cleansed and disinfected, it should be drawn firmly forward and caught in front of the

glans by long, narrow-bladed forceps. The redundant portion should be cut away in front of the forceps, when the skin will retract, exposing the mucous membrane over the glans. This should be split up over the dorsum in the median line, and trimmed off $\frac{1}{4}$ inch from the corona. The skin and mucous membrane should be united by interrupted stitches, special care being taken to secure the vessels in the neighborhood of the frenum, a little aristol or simple drying-powder dusted on the wound, and a narrow strip of sterilized gauze wound around it and fastened by thread or by collodion. In the case of infants, it is sufficient to cover the glans with sterilized gauze, changing the dressing as often as it becomes saturated with urine.

Paraphimosis.—If the prepuce is caught behind the glans penis and cannot be reduced, the condition is called paraphimosis. Edema

FIG. 286.—Cancer of the penis.

and swelling begin rapidly, and as they increase add greatly to the constriction of the parts. The dangers lie in the interference with circulation, and the infiltration and ulceration and possible gangrene.

Treatment consists in reduction under ether by careful manipulation: in some cases it will be necessary to cut the constricting band.

Balanitis is an inflammation of the surface of the glans. It is usually due to lack of cleanliness, by the irritation of retained secretions in phimosis; but it may be caused by gonorrheal or chancroidal infection. The extension of this inflammation to the prepuce is called balanoposthitis. The simpler forms need no treatment but cleanliness; the specific varieties may be troublesome.

Herpes frequently appears on the penis just behind the glans or at the orifice of the prepuce. The cause is often lack of cleanliness, phimosis, etc.; but herpes may be coincident with gonorrhea or gleet. From the tendency of herpes to ulcerate, confusion in diagnosis between

it and venereal sores is not unusual. **Treatment** consists in the use of a dusting-powder of zinc oxid and attention to local cleanliness.

Warts of the prepuce or glans are usually associated with an attack of gonorrhea or gleet, yet they may come without known reason. They may be removed by knife or scissors, or by cauterizing with silver nitrate or acetic acid. In the smaller growths the application of a powder of zinc oxid and calomel may be sufficient.

Cancer of the Penis.—Epithelioma of the penis is most frequent in cases of phimosis. Irritation of retained secretions and lack of cleanliness possibly favor the origin of the growth. There is usually little pain until ulceration is extensive. Rate of growth and involvement of the lymphatics are slow. There is danger in diagnosing phagedenic gumma as cancer of the penis: mistakes must be avoided by careful microscopical study and the use of drugs.

Treatment consists in amputation of a part or all of the penis, with removal of the inguinal glands. In amputation the corpora cavernosa should be cut through at a point a little higher than that in the corpus spongiosum, so that the urethra can be split open and the mucous membrane sutured to the skin, thus forming a covering to the stump of the penis. If the disease involves the greater part of the body of the penis, the entire organ should be removed, the crura should be detached from their pubic attachments, and the scrotum and testicles removed. In all amputations of the penis, thorough removal of all the inguinal glands should be practised.

SURGERY OF THE URETHRA.

Stricture.—Stricture of the urethra is dependent on a cicatrix that has been formed as the result of either accident or disease. A kick or blow in the perineum, or a fall across a beam with the legs astride, causing rupture of the urethra, is almost certain to be followed by stricture. In stricture due to disease there is almost invariably a history of a gonorrhea that has been imperfectly cured, and in which a gleet has persisted for months.   There are very rare cases in which no such history is obtainable, and in which the disease has been ascribed to masturbation or is assumed to have a congenital origin.

Stricture is most common in the spongy urethra, particularly in the bulb: it is very rare in the membranous urethra, and is never met with in the prostate. Oftentimes more than one stricture exists; and occasionally the whole canal is surrounded by cicatricial tissue and converted into one long stricture. The most inveterate forms are those at the meatus, where they are usually the result of cicatrization of a sore, or of contraction of the orifice following circumcision. Strictures resulting from injuries are, as a rule, more severe and unyielding than are those following upon gleet. This is due to the cicatrix being thicker, and often involving the tissues outside the urethra as well as the mucous canal itself.

Pathology of Stricture.—A traumatic stricture is formed by the cicatrization of a wound in the urethra, and oftentimes in the surrounding tissues—a dense scar replacing the normal elastic tissues. Organic stricture from disease is the result of long-continued inflam-

mation, and follows usually upon one or more attacks of gonorrhea. Unlike a traumatic stricture, it does not supervene within a few weeks or months of the original trouble. Its onset is gradual, and oftentimes hardly perceptible. When a strictured urethra is laid open after death, the constrictured portion is seen to be surrounded by cicatricial tissue, the extent and character of which are very variable.

The urethroscope shows us that a small granular patch of inflammation or an inflamed gland in the urethra gradually induces the formation of a cicatrix, which by its contraction produces a stricture; and it is probable that the reason why the neighborhood of the bulb is so liable to stricture is that morbid products may easily gravitate there in the sitting or standing position.[1] Given the presence of such inflammation, spasm is also an important factor in some cases.

FIG. 287.—Stricture of the urethra, with dilatation behind the stricture and hypertrophied bladder-walls (St. Bartholomew's Hospital Museum).

The *secondary changes* in tight stricture are very important. The urethra behind an old, tight stricture becomes dilated and thinned; its lining is inflamed, secretes a gleety discharge, and may ulcerate. The muscular coat of the bladder undergoes hypertrophy, rendering its surface irregular (fasciculated) or pouched (sacculated). If there is retention of urine, the viscus is enlarged; its mucous lining is often the seat of catarrhal inflammation. As a result of the muscular hypertrophy, the ureters and pelvis of the kidney become dilated, the pyramids of the kidney become absorbed, and the cortex chronically inflamed. A kidney in such a state very readily becomes a prey to septic infection, leading to suppurative pyelitis and nephritis, with minute abscesses scattered through the cortex.

Diagnosis and Symptoms of Stricture and other Causes of Obstruction.—It is remarkable how rarely a patient will admit any premonitory symptoms of stricture. Sometimes there is a history of the

[1] See a paper by Pearce Gould, *Lancet*, Dec. 8, 1877. Also remarks by the author (*Brit. Med. Jour.*, vol. i., p. 940, 1890) on the relation of spasm to organic stricture.

prolongation of the act of micturition, of a forked and diminished stream, and perhaps of persistent or frequently recurring gleet. If the muscular fibers of the bladder have been equal to the increased strain put upon them, there may be but little warning of the narrowing caliber of the urethra until some exciting cause, such as cold or an extra quantity of intoxicating liquor, induces an inability to empty the bladder, and the patient, in consequence, seeks the advice of the surgeon. In some cases frequency of micturition, with or without dribbling of urine, is the first indication of the trouble.

The presence of constitutional symptoms will depend on the condition of the urethra and the urine. If the difficulty is of long standing, the urinary tract will have become septic and cystitis may be present. The increased intravesical tension causes a dilatation of the ureters and kidney-pelvis, and so renders them more vulnerable to septic infection. The point of entrance of the septic organisms is in most cases a matter of conjecture, as it often occurs before the passage of a catheter. The most common forms of infection are due either to the Streptococcus pyogenes or to the Bacillus coli communis. In such cases the tongue is furred, the patient listless and apathetic, and the digestive organs disturbed; in severe cases vomiting and diarrhea form a prelude to the fatal consequences of urinary infection.

A stricture always demands surgical treatment; and when the onset of constitutional symptoms denotes a condition of sepsis, or when retention occurs, no delay should be permitted.

Retention of urine is caused either by an interference with the nervous mechanism of the act or by a physical obstruction to the flow through the urethra. The micturition-center in the lumbar cord may be inhibited, and the reflex act entirely prevented. This is seen after injuries and operations, particularly in the region of the pelvis, in hysteria, in severe shock, and in injury of the spinal cord above the lumbar region. Large doses of belladonna may produce the same effect; the so-called congestive stricture is probably always of nervous origin. A tight stricture is the most frequent cause of retention from obstruction to the outflow. Other common causes are hypertrophy of the prostate; calculus and tumor in the bladder; calculus or a foreign body impacted in the urethra; fracture of the pelvis, with displacement; peri-urethral abscess or tumor; a tight phimosis, or contracted meatus. In gonorrhea the swelling of the mucous membrane is said to form a blockade in the urethra. Overdistention of the bladder may lead to loss of power in the bladder-muscle, and so to retention of urine.

The *diagnosis* of many of these conditions is exceedingly simple for the surgeon who systematically explores the urinary tract.

The *symptoms* depend partly on the acuteness of the attack and partly on the constitutional condition of the patient. If the kidneys are diseased, a very small amount of retained urine may cause considerable discomfort and a correspondingly grave prognosis. If retention is due to disease or injury of the spinal cord, the symptoms will be few; owing to loss of sensibility, the water may begin to dribble away from the overfull bladder before the patient is aware of his condition. But if retention should occur suddenly in a young and healthy adult during the course of gonorrhea, or in consequence of any injury to the

urethra, the symptoms will be severe. Added to the urgent desire to micturate, there are severe and agonizing pain in the region of the bladder and straining, accompanied perhaps by prolapse of the bowel, or even by the occurrence of hernia. The distended bladder, unless the patient is very fat, will be felt reaching to the navel or beyond, and the urine will possibly trickle in small quantities from the urethra. If this condition is unrelieved, the patient gradually passes into a condition of uremic coma and convulsions. The *prognosis* is dependent on the treatment.

Treatment.—The method to be adopted for the relief of retention must depend upon its cause. If it be in consequence of paralysis, the passage of a catheter must be continued as long as it is required; but no pains should be spared to secure asepsis of the catheter and of the urethra, as infection is very likely to occur.

The spasmodic and congestive retention which occurs during the course of an attack of gonorrhea, though usually relieved by a hot bath, occasionally demands the passage of a catheter. If a true obstruction occurs, dependent on any of the causes just referred to, a careful examination must be made.

The exploration of the urethral tract should be conducted as follows: The patient should be placed in a recumbent position, and the surgeon, standing on whichever side he prefers, introduces a medium-sized bougie olivaire as far as he can with care and firmness. If it enters the bladder, a larger size may be selected until the limit of easy urethral dilatability is reached. If the passage is clear as far as the bladder, obviously no stricture exists. The surgeon should then proceed to explore either the urethra or bladder, or both, should he deem it desirable. If the urethra demands further examination, the writer is in the habit of employing an Otis urethrometer, by means of which its varying caliber from the bulb to the orifice can be easily detected. During the course of such an examination the presence of local constrictions, or of undue pain and tenderness, aided by a digital examination of the exterior, will afford much valuable information; and an inspection of the instrument when it is withdrawn may reveal a drop of pus, mucus, or blood, any of which conditions indicates some departure from the normal. The subsequent introduction of the urethroscope often affords confirmatory evidence of some local inflammatory state which demands local treatment.

If severe pain is evinced by the patient, cocain to the extent of 1 or 2 grains should be employed; but it is better to make at least a first examination without it if possible, as pain is an important aid to diagnosis.[1]

A complete and satisfactory examination of the prostatic urethra is by no means easy to obtain, and in some instances is almost an impossibility. By the use of a few different sized instruments, coupled with a simultaneous rectal examination, a fair knowledge of the condi-

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[1] The simplest method of administering cocain is to take two tabloids, each containing a grain, dissolve them in about ʒj of water, and introduce this by means of a small syringe to which is attached a small rubber catheter open at the end. The first 1 or 2 inches of the urethra can be rendered insensitive by injecting a few drops; as soon as local insensibility occurs the instrument can be inserted a little further and another section rendered insensitive, and so on until complete local anesthesia is produced.

tions can be arrived at. The most useful instruments for this purpose
are a couple of full-sized silver catheters of varying curve. One of
these, extra long and well curved, is known as a silver prostatic catheter.
In addition to these some full-sized olivary and Jacques catheters,
and some with a coudée and bicoudée curve, should always be at
hand to complete the surgeon's armamentarium. Indeed, it is diffi-
cult to say what form of catheter or bougie he may not require in
some cases.

Olivary catheters of different curve are perhaps more likely to
enter the bladder than any other. It is important to note how far the

FIGS. 288, 289.—Soft catheters.

catheter requires to be introduced before urine flows, as any elonga-
tion of the urethra in advanced life is almost sure to be an indication
of enlarged prostate. In some cases the urethra may be increased
from 8 to 10, 11, or even 12 inches in length.

If the prostate is not enlarged, or affords an insufficient explanation
of the patient's condition, the interior of the bladder must be examined.
Its capacity can be determined either by injecting it with boiled
water, by means of a funnel and catheter, or by measuring the amount
of urine it contains when filled. It should contain close upon a pint
without giving rise to symptoms of inconvenience. When a patient

FIG. 290.—Silver catheter.

has been in the habit of holding his water for a considerable length of
time, and the presence of a stricture or enlarged prostate has obstructed
his outflow, the bladder capacity may be raised to as much as 3 or 4
pints or more. Such a condition is always pathological, as also is that
of diminished capacity, in which this organ will hold but a few ounces.

The *introduction of a sound* will afford valuable information as to the
presence of any foreign body, such as a stone. Before introducing this
instrument the patient's pelvis should be slightly raised on a cushion,
so as to elevate it 2 or 3 inches above the rest of the body. When the
sound has reached the interior of the bladder, the beak should be
carried to its farthest limit, and exploration made right and left by a

series of light taps, until the orifice is reached. If the stone is lying on the back wall of the bladder, it will almost certainly have given some indication of its presence. Behind the prostate the beak must be reversed, as a depression often exists here to which a stone is very likely to gravitate.

A series of sounds of varying curve may be required, in order to explore the depressions and sacculi which sometimes surround a bladder, and in which a stone may remain concealed even after the most carefully conducted sounding. Contact with the stone elicits a sound, and the sharpness of the sound is an index of the hardness of the stone.

Should the diagnosis still remain uncertain after sounding, the *cystoscope* may be employed. In order to obtain a complete view of

FIG. 291.—Sound.

every portion of the bladder two instruments are used, one to illuminate the upper hemisphere and the other the lower. This latter instrument is usually introduced first, as it is in this zone that by far the greater part of the pathological conditions of the bladder will be discovered. Its introduction offers no special difficulties to the surgeon who is familiar with sound and lithotrite, unless the prostate is irregularly enlarged or stricture is present; but the presence of much pus or blood in the urine so obscures the view as to render an exact diagnosis difficult. Under such circumstances the bladder must be washed out and clean boiled water introduced. Sterilized glycerin should be used as a lubricant for the cystoscope, in order to avoid smearing its glass window and rendering it opaque. It is difficult to

FIG. 292.—Cystoscope.

manipulate the cystoscope when the bladder contains much less than 5 or 6 ounces of fluid; and it is often advisable to inspect that organ under different degrees of distention, if obscure pathological phenomena have to be cleared up. The light should be carefully examined and the rheostat adjusted before beginning an examination. Otherwise there is considerable risk either of fusing the lamp or of obtaining an insufficient light. To interpret properly the facts that are observed, much practice is essential. Various conditions may be revealed—a stone may be seen lying at the bottom of a sacculus, a foreign body detected, a tumor discovered, or a source of hematuria or pyuria determined with absolute certainty.

It has been assumed, so far, that the urethra is pervious to instruments. If this is not the case, and the bougie or catheter is brought

to a standstill by some obstruction, a smaller instrument must be employed. Not infrequently the patient's urethra has been explored before, and possibly one or more false passages exist, the result of careless or ignorant instrumentation. A small instrument especially is always likely to re-enter them, or may find its way into the orifices of urethral glands or encounter folds of mucous membrane. Practice alone can enable one to ascertain with certainty that he is in the right track. In cases of difficulty it is well to remember that the penis must be tightly drawn up over the instrument, so as to pull out the folds of its mucous membrane, and that manipulation must be gentle.

Possibly a guide-bougie is the only instrument that will enter after repeated attempts, and sometimes nothing can be introduced into a bladder, even under the influence of an anesthetic. In such a case operative interference is urgently called for. If the patient can get rid of his water, it is often best to keep him in bed for a few days, in the hope that quiet and warmth may diminish the congestion and spasm which are always present in such cases. A second attempt to introduce an instrument may then be made; but if it also fail, no further delay must be countenanced. Recourse must be had in the case of stricture to Wheelhouse's or Cock's operation (see p. 541).

Relief can always be obtained by *puncturing the bladder above the pubes with an aspirator.* It is not desirable to aspirate frequently, for, though the aperture in the bladder-wall readily heals if it is subjected during the next few days to a moderate amount of distention only, yet in case considerable overdistention is permitted to recur, the edges of the puncture will gape, and urine may find its way into the prevesical cellular tissue and give rise to fatal sepsis. It should be borne in mind, therefore, that this method of treatment is but a temporary measure.

If, however, the age of the patient or the condition of his urethra renders it inadvisable to make an attempt to remove the source of obstruction, a large-sized trocar should be used, and a rubber catheter passed through it into the bladder, with a view to making the opening permanent. Puncture of the bladder through the rectum should not be practised.

Obstruction by Calculus or Foreign Body.—Possibly during the course of his examination the surgeon may conclude that the obstruction is due either to an impacted calculus or to the presence of a foreign body. There may be a history of sudden pain radiating down the penis and along the thighs, accompanied by difficulty in micturition, which a few days later caused retention. Such a history, especially in children, points with almost absolute certainty to an *impacted calculus,* which should either be pushed back into the bladder and crushed, or, if this be deemed inadvisable, cut down upon and removed. Its exact position must first be determined by palpation and the aid of a sound. In rare instances stones have remained embedded in the wall of the urethra for years; but such a condition implies the absence of complete obstruction. In such a case its presence is eventually manifested by an abscess, which when opened reveals at once its origin and cause.

Foreign bodies include every conceivable variety of material, from hairpins and slate-pencils to broken catheters. They may be introduced by the insane, by adults as a sexual stimulus, or from mischiev-

ous motives by young children. The motives which prompted their introduction are often concealed from the surgeon until the extraction of the foreign body renders further attempt at deception useless. It is difficult to lay down absolute rules in such cases. Their accurate diagnosis will usually tax the surgeon's powers and afford a curious insight into the freaks of human nature. They should be extracted, if possible, by the natural route, without damage to the urethral wall. A pair of urethral forceps (Fig. 293) with crocodile-bill is the best variety to use for this purpose.

Sometimes the foreign body can be coaxed by manipulation either to the orifice of the urethra or into its deeper parts. An incision for the extraction of such objects should always be made, if possible, behind

FIG. 293.—Urethral forceps.

the scrotum, as no difficulty will be experienced in getting it to heal in that situation.

Treatment of Stricture.—The principal methods of treatment that are now employed are (1) gradual dilatation; (2) rapid dilatation with or without retention of a catheter; (3) external urethrotomy; (4) internal urethrotomy. For the treatment of most strictures gradual dilatation is all that is demanded. A stricture that will admit a No. 7 or 8 French will usually, a few days later, permit the passage of a No. 12 or 13. In a short time the urethra is completely dilated, and by the occasional passage of a full-sized bougie may be maintained in this condition; but if the stricture is of long duration, it may resent this treatment, or at any rate not improve under it. It may be very irritable and rapidly recontract, or bleed on the slightest provocation, and be attended by a rise of temperature whenever touched.

If any of these conditions occur, more radical means are demanded. The patient must be confined to bed. A few days' rest in bed, with careful dieting, the avoidance of stimulants and irritable condiments, and the administration of large doses of alkalies, such as ʒj of potassium citrate two or three times daily, will often work wonders with an irritable urethra. To this may be added, if the urine is foul, 10 grains of salol two or three times daily, in order to render it as nearly aseptic as possible. If continuous dilatation is to be resorted to, the largest catheter that the urethra will admit is introduced and tied in for twenty-four to forty-eight hours, at the end of which time another, two or three sizes larger, will be found to pass easily, and is in its turn succeeded by a still larger one. After four or five days the case can usually be proceeded with by gradual dilatation, which has already been described. When it succeeds, rapid dilatation sometimes yields excellent results, and converts an irritable and troublesome stricture into one that is easily manageable, if a catheter is introduced from time to time. Its
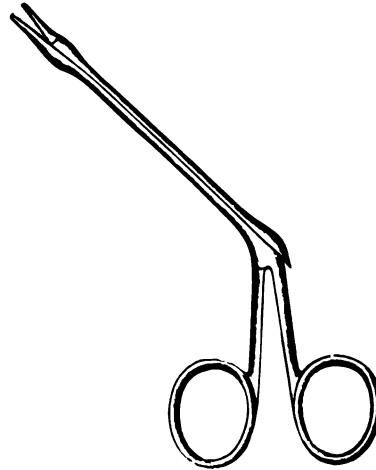
disadvantages are that it is oftentimes attended by considerable pain and rise of temperature, and that the stricture rapidly relapses into its former troublesome condition. When a sudden attack of retention ensues, it is often the only method that is available, and it rarely fails to relieve the patient, at least temporarily.

If a stricture is very irritable and rapidly recontracts, it is sure, unless some operative interference is undertaken, to cause attacks of cystitis, and sooner or later pyelitis in addition. *Urethrotomy*, either external or internal, is then urgently demanded. Internal urethrotomy should be performed wherever it is possible to pass anything at all through the stricture. When no instrument whatever can be introduced, external urethrotomy is the only safe mode of procedure; but it is not required in more than 2 or 3 per cent. of these cases. Its disadvantages are that it is a more serious operation, necessitates the escape of the urine for some days by the wound, and keeps the patient in bed for three or four weeks or more, whereas after internal urethrotomy he is often up and about within a fortnight or less.

Internal Urethrotomy.—Numberless instruments have been devised for this operation. If the stricture is in the penile urethra and can be rendered pervious to a No. 12 or 13 French, a straight, blunt-pointed bistoury is all that will be required for the purpose. The operator grasps the penis in one hand, and with the other guides the bistoury; he need not be in any fear of cutting too deeply, and it is better to incise the stricture in more than one part of its circumference.

When the stricture is more deeply placed, and when it admits only a filiform bougie, a urethrotome is essential, and the form which I usually employ is that known as Teevan's modification of Maisonneuve's instrument (Fig. 294). The guide-bougie is first passed through the stricture into the bladder, and the urethrotome then screwed on it. The instru-

FIG. 294.—Teevan's urethrotome.

ment is carefully guided through the urethra until it comes to a standstill, when the knife is unsheathed and the stricture incised in one or more parts of its circumference. A full-sized steel bougie is then passed, and a large-sized catheter (preferably a Jacques) passed into the bladder and fixed there. The bladder is washed out three or four times, first with some antiseptic,[1] and afterward with boiled water, and the catheter is retained usually for forty-eight hours. About the eighth day a full-sized bougie is passed, and this is repeated every other day till the patient is convalescent. The permanence of the result depends almost

[1] The author now invariably uses izal, 1 : 160 (℥j : Oj), for the purpose.

entirely on the regular passage of a full-sized instrument during the first six months or a year. The instruments which are best for such purpose are steel bougies, slightly conical and highly burnished. A set comprises the following sizes in English measurements: Nos. 1 to 4, 2 to 7, 4 to 9, 6 to 12, 9 to 15, 12 to 18. The two smaller sizes are furnished with screw caps, so as to enable a whip-bougie to be affixed to them if necessary. These conical bougies are also very useful for obtaining the rapid dilatation of tight strictures. If the stricture admits the passage of a filiform guide, the smallest bougie can be
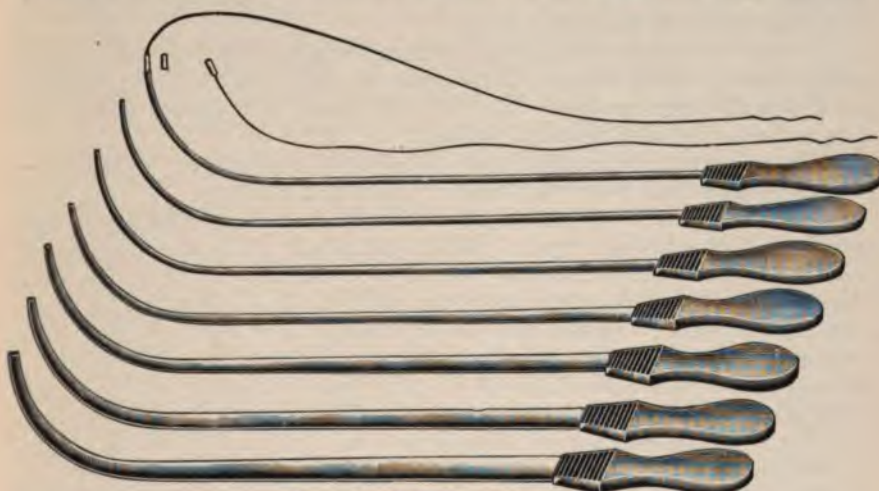
FIG. 295.—Conical dilating sounds.

attached to it and guided through the stricture, and afterward one or even two larger ones passed, so that at once dilatation sufficient to prevent retention of urine is accomplished.

External urethrotomy is only required when the surgeon is unable to introduce a filiform bougie after an anesthetic has been administered. No operation offers so many advantages as that which is associated with the name of Wheelhouse, of Leeds. The mode of performing the operation is as follows: The patient is secured in the lithotomy-position, and a Wheelhouse staff passed down as far as the stricture. The

FIG. 296.—Wheelhouse's staff.

urethra is opened where it is still healthy, at least $\frac{1}{2}$ inch in front of the stricture. The staff is then turned round so that the groove is turned away from the operator, and, by means of the hook, which now faces him, the upper portion of the wound is held up by his assistant at the same time that the edges are held open by two pairs of artery- or pressure-forceps, one on either side. He is now face to face with the stricture. Sometimes its track is sufficiently obvious to enable him to divide it readily and find his way without difficulty into the urethra behind, which is almost invariably dilated. It is always advisable to

operate, if possible, when the bladder is full, as pressure over the pubes will often cause a few drops of urine to exude, and so disclose the strictured channel. Partly by such means as this, and partly by tracing down the mucous membrane, the stricture is eventually divided and a Wheelhouse gorget passed through the prostatic urethra into the bladder. It remains to insert a full-sized catheter and retain it, as a rule, for about forty-eight hours. Five or six days later a steel bougie of medium size is passed through the penis, care being taken to avoid its emerging by the perineal opening, instead of finding its way into the bladder. Dilatation must be persevered with in the same manner as in a case of internal urethrotomy.

In rare instances, where the stricture is not extensive it has been excised and the two ends of the urethra sutured, with excellent results; or a Wheelhouse operation may be completed by a careful suture of the wound over a full-sized catheter.

The treatment of retention due to enlarged prostate or to bladder-tumor is discussed under the head of Enlarged Prostate.

Extravasation of urine is the result of disease or injury of some portion of the urinary tract. Most commonly it is a consequence either of injury to the urethra behind or of ulceration of a stricture. In such cases the urine infiltrates the cellular tissue, usually with considerable rapidity. Limited by the attachment of Colles's fascia to the triangular ligament of the perineum, and to the fascia lata of the thigh, it passes into the loose tissue of the scrotum and penis, and finds its way along the front of the abdomen, occasionally as far as the axilla; but it cannot pass backward around the anus and down into the thigh.

More rarely the lesion affects the urethra, where it lies between the two layers of the triangular ligament, or even further back still, in which case the cellular tissue of the pelvis is involved, and the urine finds its way into the iliac fossa up along the front of the vertebral column, and if the wall of the bladder is ruptured on its peritoneal aspect, it may enter the peritoneal cavity. Extravasation may also take place in consequence of injury to the ureters or kidneys. When the term extravasation is used without any qualification, it is usually applied to an escape of urine into the fascia in front of the triangular ligament— by far the commonest variety of this condition.

Extravasation from Rupture of the Urethra.—The injuries which are liable to cause extravasation are rupture of the urethra or fracture of the pelvis. Rupture of the urethra may occur anywhere in its course. It is usually caused by a fall or blow in which the perineum is severely bruised, and occasionally occurs during coitus or in consequence of an attempt to straighten a penis which is the subject of chordee. It may be partial and so slight as scarcely to call for notice; or it may involve the whole circumference of the urethra. It is usually attended by pain of a more or less severe character and the passage of at least a few drops of blood. If the urethra is examined from the outside, the seat of rupture can usually be detected by the effusion of blood which has taken place at the seat of injury, and which, if it is sufficient to block the lumen of the canal, would be followed, when the next act of micturition occurred, by extravasation of urine. In the severer varieties, which are commonly the result of a fall astride a

beam, there is generally so much bruising as to preclude any possibility of making out the condition of the urethra from outside, and possibly some extravasation will have taken place into the surrounding tissues before the patient comes under the surgeon's care. There are often, however, retention of urine and a full bladder.

If able to void his urine without its escape into the surrounding tissues, the patient should be kept in bed for a few days, until all bleeding has ceased, so as to give the rent in the urethra a chance to heal before catheterization is attempted. After a few days have elapsed a bougie should be passed, in order to determine the extent of the injury which the urethra has undergone, and appropriate means must be adopted for preventing, by gradual dilatation, the stricture which is almost sure to form at the seat of injury. If the rupture is complete, or nearly so, the patient will be unable to get rid of his urine. It will find its way into the surrounding tissues, giving rise to extravasation.

Treatment.—No time should be lost in dealing with such a condition. The patient should be placed in the lithotomy-position, and an instrument, preferably a Wheelhouse staff, passed down as far as the seat of rupture, so as to act as a guide to the median incision that should be made in order to expose the injured structures. Through it the ends of the torn urethra will be easily found, any bleeding points secured, and the blood-clot removed as far as possible. A catheter must be passed along the whole course of the urethra and retained in the bladder, so as to approximate as far as possible the divided ends and minimize the stricture which is sure to follow such a state of affairs. If the rupture is of quite recent origin, the ends of the divided urethra should be sutured, care being taken not to leave any portion of the suture within the lumen of the urethra. If the two ends of the ruptured canal lie freely exposed, and the bulb is not broken off short in front of the triangular ligament, the suture is easily accomplished. If firm pressure is applied over the perineum, there is a fair chance of union by first intention. Means, however, should always be taken to insure that any urine subsequently escaping will find its way readily outside, and not extravasate into the surrounding tissues. The catheter should be retained for three or four days, and passed daily, if possible, for several weeks, in order to prevent the formation of an irregular and tortuous stricture. Oftentimes, however, it is quite impossible to reintroduce the instrument, and it is only too evident that no union has taken place, as but little, if any, urine passes by the penis, most of it finding an exit through the perineal wound. In such a case expectant treatment must be pursued, and as the parts surrounding the seat of injury begin to solidify, attempts should be made from time to time to introduce an instrument, coupled, if necessary, by a reopening of the perineal wound. This may require to be done more than once before the urine will pass through the whole length of the penis. Such cases are not so hopeless of cure as might be imagined.

Extravasation as a result of stricture usually follows a somewhat different course. Gradual diminution of the lumen of the urethra has probably been in progress for years, and the bladder has not been able to empty itself completely. The urine becomes septic, and has to be forced under considerable pressure through a narrowed channel. The

septic urine gives rise to ulceration behind the stricture, and finds its way, perhaps only to the extent of a few drops at first, into tissues surrounding the urethra, and a peri-urethral abscess is the result. For this condition to occur it is by no means necessary that the stricture should be of very small caliber, and many such cases can be appropriately treated by incising the abscess from outside and performing an internal urethrotomy, in which case all symptoms will probably be quickly relieved without the passage of a drop of water through the abscess-cavity; but when the abscess is more extensive and has passed further away from its original situation, either backward toward the anus or forward into the scrotum, freer incisions will be necessary, care being taken at the same time to divide the strictures.

If, however, the wall of the urethra is weakened by prolonged congestion, and the surrounding tissues are perhaps slightly inflamed, as is evidenced by their thickening, a sudden strain may cause urine to exude in considerable quantity. It follows precisely the same course as in a case of ruptured urethra; but there is one great difference between the two conditions. The extravasation consequent on stricture presupposes septic urine, and rapidly sets up a septic cellulitis, followed by gangrene and extensive sloughing of the tissues of the scrotum and penis, which can only be arrested by free incisions into all the edematous area. This condition is attended with grave constitutional disturbance; the skin is dry, tongue dry and brown, pulse very rapid and weak, and the temperature is raised or sometimes subnormal. As the patients are often the subjects of secondary renal disease, the condition is one of great peril. The extravasation which accompanies the ruptured urethra is, as a rule, not septic to start with; the mischief it sets up in the surrounding tissues is at first comparatively trifling, and the treatment it demands is therefore proportionately less severe.

Extravasation may also be produced by an *impacted calculus*, especially in children, and more rarely by the blocking of the urethra by débris from higher up in the urinary tract.

AFFECTIONS OF THE PROSTATE GLAND.

Acute Prostatitis.—Acute inflammation of the prostate is in the great majority of the cases dependent on gonorrhea which has perhaps been injudiciously treated by strong injections. It may also result from the irritation of calculi or the clumsy passage of an instrument, and is said to be produced by excessive copulation. It is usually ascribed by the patient to sitting on a damp stone or other unlikely cause; but in such case it will usually be found, on further inquiry, that the man is the subject of an old gleet, entirely neglected or injudiciously managed. Cold and exposure may render the part unable to resist the virus of gonorrhea, and in that way play some part in the causation of prostatitis. The exact starting-point of the inflammation is usually doubtful. Some authors speak of periprostatitis as distinguished from inflammation of the prostate itself. No useful purpose is served by such a distinction. The onset of the disease is usually gradual and insidious. Micturition may be slightly more frequent, and a sensation of weight experienced in the perineum. All at once, however, a long bicycle-ride,

some injudicious exposure to cold, or undue indulgence in sexual intercourse will induce an acute and painful swelling about the parts affected, and the patient develops a high temperature, perhaps accompanied by rigors, retention of urine, and great tenderness in the region of the lower bowel, the neck of the bladder, and neighboring parts. The inflammation is liable to run on to suppuration, marked by greater pain and increased swelling of the part, and often a baggy sensation or actual fluctuation can be felt on rectal examination. Retention of urine now often occurs. A *prostatic abscess* may burst into the urethra or burrow into the rectum and perineum. The passage of a catheter for the relief of retention is not infrequently the means of rupturing the abscess into the urethra.

Treatment.—If the inflammation is to be arrested before abscess ensues, the treatment should be energetic. The patient must be confined to bed and treated by hot baths night and morning, or oftener. He must lie in such a position as will tend to reduce the congestion of the affected parts; and if the symptoms do not begin to abate in a few hours, a dozen or more leeches applied to the region of the perineum will usually relieve his pain and cause the threatening signs of abscess to disappear. Free purgation with calomel, the use of belladonna suppositories, diluents, and a low diet will materially aid. If the pain still continues, in all probability an abscess will result, and the perineum and rectum should be examined at least once daily with a view to the early evacuation of any pus that may be formed. It is doubly important to detect pus early in the disease, and far better to make an incision too early than to delay it to too late a stage, for if once the pus starts burrowing in or around the prostate, though it commonly finds its way eventually into either the urethra or rectum, the damage which it has inflicted on the surrounding parts may be irreparable, and months may ensue before the patient can resume an active life. A catheter should not be employed unless it is absolutely necessary to relieve retention.

The best way to open a prostatic abscess is to make a transverse or crescentic incision in the perineum, avoiding the rectum on the one hand and the urethra on the other, so that the pus may find a ready exit without risk of contamination from either passage. If the attack is a severe one, and free evacuation is not afforded for the pus, general sepsis will ensue, ending in death from exhaustion. As a rule, however, the symptoms of constitutional disturbance speedily disappear, whether the pus is evacuated by nature or by art.

Chronic Prostatitis.—Some cases of prostatic inflammation, though showing but little tendency to run on into abscess, are equally slow to clear up. The pain gradually ceases and the swelling abates; but a sensation of weight in the perineum remains, coupled with a thin mucopurulent discharge by the urethra. The prostate feels soft and doughy when examined through the rectal wall, and is slightly tender to the touch. The symptoms are now so slight that it is difficult to persuade the patient that there is any further need for care and treatment. He is fortified in this view of his case when he finds that moderate exercise and an occasional indulgence in sexual intercourse appear to be rather beneficial than otherwise. Some cases fall into this condition to start with without passing through the acute stage at all.

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They appear as a sequela of a neglected gonorrhea. No condition is more difficult to cure.

Such cases must be carefully distinguished from *prostatorrhea*, a condition which occurs usually in young men who have been the subject of prolonged unsatisfied sexual excitement or given to masturbation, and occasionally occurs in those who are older when straining at stool. The discharge consists of mucus, in appearance like the uncooked white of an egg, streaked perhaps with whitish filaments, and sometimes it contains a few spermatozoa.

It is often associated with varicocele and a dragging pain in one or both testicles. The only rational treatment consists in removing the cause and reassuring the patient, who is usually much perturbed in his mind. This, coupled with active exercise and a non-stimulating diet, usually suffices to complete the cure.

Tubercular disease of the prostate is usually secondary to tubercular disease of the testicle, or, more rarely, of the bladder. An examination of the affected part per rectum discloses probably some nodular lumps about the prostate and region of the vesiculæ seminales, which sometimes break down and form abscesses. Soon, however, the disease involves the bladder as well, and vesical irritability proclaims the true nature of the disease, and the microscope confirms the diagnosis. If the symptoms are severe and involve the bladder, ulceration of the mucous membrane of the base of the bladder can usually be seen with the cystoscope. Most of these cases run on from bad to worse, and septic affection of the whole urinary tract soon brings about the inevitable termination.

Treatment.—Great relief is often afforded by the use, three or four times daily, of emulsion of iodoform suspended in mucilage or olive oil, and in some instances, especially if the bladder is regularly washed out with scrupulous care and the patient is able to take a sea-voyage, complete recovery ensues (see Tubercular Disease of the Bladder).

Surgical interference is rarely indicated, as the suprapubic wound necessary for the purpose is liable to become the seat of tuberculous growth and to cause additional trouble. When, however, the ulceration is limited in amount, and by its close proximity to the vesical orifice gives rise to excessive pain in micturition, benefit does undoubtedly arise from active surgical interference; but this should only be employed after other means have entirely failed to give relief. If it is undertaken, the tubercular ulcers and sinuses should be thoroughly scraped and cauterized and iodoform freely introduced. The use of lactic acid and other drugs has been lauded by some authors, but nothing has yielded the author such good results as iodoform.

Tumors of the Prostate.—Non-malignant tumors of the prostate are exceedingly rare, excepting those associated with enlarged prostate, which will be further alluded to when that subject is treated. Simple cysts may be found in museum specimens, but can hardly be said to be known clinically. Hydatids invade its capsule rather than the glandsubstance. The symptoms which they present vary in accordance with their size and exact situation. In the only 2 cases of this condition that I have come across retention was the prominent symptom, and the swelling was discovered during the steps taken for its relief.

Malignant tumors (carcinoma and sarcoma) of the prostate occur,

as a rule, either quite early in life, before eight or nine years of age, or after forty-five. Occasionally the prostate is invaded by secondary growths at the same time that there are well-marked symptoms of malignant disease existing in other parts of the body. The *symptoms* of the disease are, in the earlier stages, vesical irritability, coupled later on with hemorrhage, and often attended by considerable difficulty in emptying the bladder. In the early stages diagnosis is difficult, but as it advances an examination per rectum will indicate the presence of a hard swelling invading the prostate gland and fixing it firmly to the surrounding parts. Removal of the tumor is impossible ; all that can be done is to relieve the patient by drawing off the water if retention occurs, and occasionally by making a suprapubic opening if the natural passage gets blocked. Under these circumstances, as well as when a similar relief is demanded, it is better in bladder-tumors that are irremovable to perform the operation like an inguinal colotomy, in two stages, in the first of which the peritoneum is opened and the bladder stitched to the abdominal wall. A few days later, when the peritoneum is completely shut off, the bladder can be incised or punctured and a suitable catheter inserted. By this plan complete asepsis can be insured, and the patient suffers far less inconvenience than is experienced when the ordinary suprapubic operation is performed.

Prostatic calculi are common in the prostates of elderly men. They are about the size of a millet-seed. They vary in number from one or two to several hundred. They rarely give rise to any symptoms unless inflammation is set up in the gland by their presence. Sometimes they are voided by the urethra, and in very rare instances ulcerate into the retroprostatic pouch and form the nucleus of a vesical stone. They are formed in the crypts of the prostate by a deposit from the secretion of the gland, and consist chiefly of carbonate and phosphate of lime. They rarely call for treatment. If symptoms of vesical irritability are accompanied by the passage of such calculi, an attempt should be made to wash them out with an evacuator.

Enlarged prostate is a very common accompaniment of advancing years. Indeed, it is comparatively rare to find a prostate in a man over fifty-five or sixty years of age that is not to some extent enlarged. It is exceedingly rare for the disease to begin before fifty-five years of age or after seventy; although when it has once commenced, it may go on increasing up to the end of life.

Etiology.—Absolutely nothing is known of the cause of this enlargement except that it is associated with the sexual function. The prostate is never enlarged in eunuchs or in those who have lost both testicles by accident or disease. A similar absence of prostatic enlargement is also observable in congenital deficiency of both testicles. In all these conditions the prostate is not only not enlarged, but exhibits the character which that organ presents before the advent of puberty. I have several times examined patients in whom one or both testicles were absent or had never functionally existed, and have invariably found an absence of the corresponding half of the prostate. It has been shown by the experiments of Joseph Griffith and others that a similar relationship exists in dogs and other of the lower animals. These facts have been made use of in the treatment of this affection.

Pathology.—The enlargement of this organ may involve the whole or only a portion of the gland. Usually the enlargement is general, causing the gland to project toward the rectum as well as into the bladder, and encroaching also on the prostatic urethra. Occasionally the urethra is increased in length to the extent of 2 or even 3 inches. The muscular, glandular, and connective-tissue elements do not participate equally in the enlargement. The enlargement is, as a rule, chiefly at the expense of the connective-tissue elements. Often small isolated
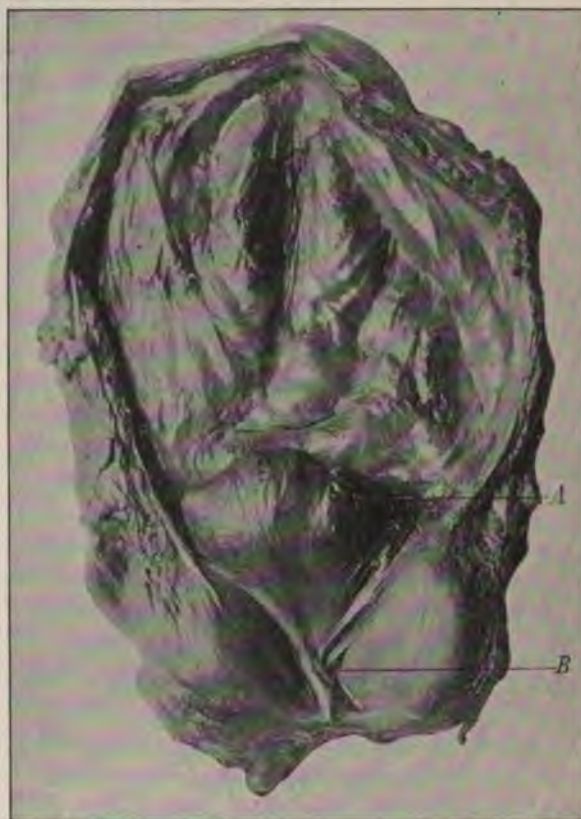
FIG. 297.—General enlargement of the prostate. The divided surfaces of the supra-urethral portion and the large median lobe show well. Catheterization was possible in this case only with a metal prostatic catheter, the point of which invariably turned to the patient's left on entering the bladder; profuse bleeding always followed the introduction of the instrument. *A*, point in middle lobe against which the catheter impinged and from which the hemorrhage came; *B*, veru montanum (White and Wood).

tumors occur in the substance of the organ. They consist of unstriped muscular tissue, and are similar in structure to the myomata of the uterus, though they differ from these tumors in that they appear when sexual life is well on the decline, instead of during its period of greatest activity. In most cases the bladder becomes distended and its muscular wall thinned; as a result of this, the ureteral valve is opened out, the ureters and pelvis of the kidneys dilated, and pressure-changes occur in the kidney. In some cases the bladder is small, the muscular

coat hypertrophied, and the surface of the organ fasciculated or sacculated. The changes of cystitis may be superadded.

The **symptoms** are insidious in onset. The patient is usually aware that his stream has been slower and less forcible than was formerly the case. His calls to pass water are more frequent, and he gets up once or twice or oftener during the night to empty his bladder, and passes only a few ounces on each occasion. When he imagines he has com-

FIG. 298.—Silver prostatic catheter.

pletely emptied his bladder, the passage of an instrument reveals the fact that it contains a further amount, perhaps from 4 to 6 ounces or more, of "residual" urine which he cannot voluntarily void. If a catheter is regularly passed once or twice during the twenty-four hours, all symptoms of discomfort will in many cases disappear, and no further treatment will be needed. But it is not in all cases that

FIGS. 299, 300.—Soft prostatic catheters.

such a favorable result can be predicted. Quite apart from the dangers of sepsis, which may occur at any time, especially if urine is allowed to accumulate in the bladder, the residual urine may grow larger and larger in amount, until it monopolizes the whole of the bladder and all the urine has to be drawn off by the catheter. The desire to urinate becomes more and more frequent both by day and by night, and the patient, worn out by lack of sleep and sheer exhaustion, is carried off by some intercurrent disorder. Attacks of hemorrhage from the enlarged prostate often occur, the blood collecting in the bladder and becoming more or less intimately mixed with the urine. If these attacks become frequent or last long, they greatly add to the exhaus-

tion of the patient, and may prove fatal. The true cause of the unto-
ward progress of the disease may not be easy to determine, but always
demands a thorough examination, as the future welfare and comfort of
the patient largely depend on the accurate diagnosis and proper treat-
ment of the affection. It is always well to bear in mind that many of
these cases are complicated by the presence of a stone (see Calculus,
p. 556), and that the irritability of the bladder depends more on this than
on the increased size of the prostate. The bladder must be carefully
sounded, if necessary with the aid of an anesthetic. The cystoscope
may be employed as well. The capacity of the bladder, both with and
without an anesthetic, should also be determined. Assuming that the
presence of a vesical calculus and of a vesical tumor has been nega-
tived by the examination, the trouble will have been narrowed down
to the prostate itself. It may be largely increased on its vesical aspect,
and project into and encroach on the bladder, forming a growth in its
interior almost as large as an orange. If this is the case, it is almost
certain that some radical measure is called for.

Treatment.—In the slighter forms of the affection, it is sufficient to
regulate the diet and bowels, to insert a belladonna suppository at
night, to be careful to avoid exposure to cold and damp, which might
cause prostatic congestion, and to pass water at regular intervals.
When there is a distinct amount of "residual" urine, the bladder
should be emptied by catheter at regular intervals, great care being
taken to prevent infection by the catheter. By this means the bladder
may recover its power and the need for the catheter may pass away.
But in other cases the bladder becomes weaker and weaker, until the
patient is entirely dependent upon the catheter; and if to this is added
great irritability of the bladder, the patient's condition is one of great
misery. The best catheters for these cases are the soft-rubber Jacques
catheter or the French catheter coudée or bicoudée (Figs. 299, 300).
When the prostate is very large and firm and these catheters cannot
be passed, a long, very curved silver "prostatic" catheter can generally
be readily inserted (Fig. 298). Should it be found impossible to pass
any instrument into the bladder—a very rare event—the retention of
urine must be relieved by opening the bladder above the pubes and
inserting a cannula; or, if the case is otherwise suitable, prostatectomy
may be performed.

When hemorrhage occurs, the patient must be kept at rest in bed,
on liquid diet, and ergot with chlorid of calcium should be given in
full doses. If the urine is foul, owing to some form of septic infection
of the bladder, it must be washed out daily. In the author's experi-
ence no antiseptic is so effective as izal in the proportion of 1 : 200.
After this fluid has been all evacuated, a few drops of silver nitrate
(10 grains to the ounce) may be introduced and allowed to remain.

. **Operations.**—If these measures fail and the general condition of the
patient seems to warrant such a procedure, operative interference must
be resorted to without delay. Experience alone will enable the sur-
geon to decide when it is advisable to have recourse to an operation.
Operations for enlarged prostate are rarely required except in those
who are advanced in years, and who are oftentimes broken down by
long-continued suffering, and the right moment for surgical interference

is often difficult to determine. Furthermore, it is by no means easy to decide what operation is best suited to the case in question.

The relationship of the testicles to the growth of the prostate has already been alluded to; but it is only of recent years that the researches of White in America, and of Joseph Griffith, Moullin, and others in England, have rendered it practicable for surgeons to advise the removal of the testicles with a view to causing diminution of the size of the prostate and the restoration of natural micturition. Those who have tried this method of treatment are by no means unanimous in its praise, and the author's own experience tends in the same direction. It has already been pointed out that the enlargement of this gland affects it in different parts, and as a rule is chiefly dependent on an increase of its connective-tissue elements. The enlargement may be very considerable, and yet not affect either the cavity of the bladder or the caliber of the urethra. Such a condition requires no surgical aid at all, and, indeed, is rarely discovered except at an autopsy. The hindrance to micturition is often dependent on a small overgrowth of prostate-tissue in the prostatic urethra or at the entrance of the bladder. If accurately diagnosed, they may be removed with lasting benefit to the patient and with scarcely an appreciable risk to life, but this is not always possible. If the increased growth is considerable on the vesical aspect, and is associated with a constant desire to micturate and by all the distressing symptoms above alluded to, in all probability some operation will be required. Such cases are eminently suitable for suprapubic prostatectomy, and if the operation is successfully performed, the cure will be in all probability permanent; but the risk to life is, it must be admitted, considerable. If, on the other hand, the prostate is soft and spongy to the feel and there is but little evidence of an outgrowth in a special direction, the condition is more likely to be relieved by castration.

In a certain number of these cases in which removal of the testicles has been practised, the patients have displayed serious mental symptoms and have developed into helpless imbeciles. In one such case which occurred under my care, didymin tabloids were administered and speedily restored the patient to his normal condition. In order to diminish the size of the prostate without endangering the patient's mental equilibrium, single and double *vasectomy* have been proposed as substitutes for castration, and in some instances the result has been excellent, and bids fair, so far as my own experience goes, to remain a permanent one. But the result of all these operations is far from being a certainty. In some instances the patient is no better, so far as his powers of micturition are concerned, than he was before the operation. In the present state of our knowledge it is quite impossible to point to any one operation which can be in any sense described as a panacea for the evils of prostatic obstruction; but by judicious treatment and careful management it is possible greatly to alleviate them.

Vasectomy is an operation almost entirely devoid of risk, and can be performed, if it appears to be desirable, under cocain. The vas is isolated by the finger in the upper part of the scrotum or just external to the abdominal ring, the skin over it is incised, and the vas itself divided with either a knife or scissors. As a rule, no vessel need be ligatured,

and one stitch in the skin is all that is required, a few days' rest sufficing to effect a complete recovery from the operation.

Castration is performed by making an incision into the scrotum so as to expose the testicles, which are separately isolated. The cord is transfixed in two or more places and tied in bulk, a far simpler proceeding than separate ligature of its vessels. The superfluous scrotal tissue should be removed, so as to insure rapid healing.

Prostatectomy should always be performed, to start with, by the suprapubic route. It is quite easy to make a perineal incision later in the operation, if any portion of the growth prove to be beyond reach of the finger. The mode of operating is the same as that employed in ordinary suprapubic lithotomy (see page 559), except that it is well to remember that it is far easier to keep the walls of the bladder apart when the patient's body is placed at an angle of 45 degrees (Trendelenburg position). The edges of the bladder should be fixed by temporary sutures to the edges of the abdominal incision, so as to avoid tearing it from its surroundings. A pedunculated middle lobe can easily be removed with the finger or with curved scissors. When the growth to be removed is more extensive, an incision through the mucous membrane should be made with a knife, and the obstructing portion of the prostate enucleated with the finger, raspatory, or other similar instrument. It can be removed piecemeal with scissors curved on the flat, if necessary, and the hemorrhage, which is not usually excessive, arrested by means of sponges soaked in hot water.

The urethra should be examined to see that it is not the seat of a prostatic upgrowth. If one is discovered, it must be removed at the same time, or the result will be failure. A suprapubic tube should be kept in for three or four days. The safety of the operation largely depends on the degree of foulness of the urine and the state of the kidneys; care, therefore, should be taken beforehand to make the urine as nearly aseptic as circumstances will admit.

AFFECTIONS OF THE BLADDER.

Ectopia Vesicæ.—In this condition the front wall of the bladder is entirely absent and the innominate bones fail to meet at the symphysis pubis. The lower part of the abdomen is occupied by an inflamed and irritable mass of mucous membrane some 2 or 3 inches in diameter, on the surface of which the two ureteral orifices can be detected; this terminates below in a short, trough-like urethra, open on the dorsum—epispadias. The pressure of the intestines behind forces forward the back wall of the bladder, rendering it, as a rule, all but impossible to construct any cavity capable of holding more than a few drams of urine. A few cases survive to old age, a nuisance to themselves and their friends; but as a rule death occurs early in life, as a result of septic inflammation spreading up the ureters.

Treatment of this condition resolves itself either into the employment of a rubber shield with a view to protecting the irritated mucous membrane, or an attempt to form an anterior wall to the bladder; but the formation of any approach to a sphincter has so far proved beyond the reach of surgical skill. Surgeons have attempted to remedy this con-

genital defect in one of three ways : (1) by approximating the defective bony symphysis ; (2) by turning up skin-flaps to form an anterior wall to the bladder ; (3) by making some communication between the urinary tract and the rectum.

Wounds of the Bladder.—An incised wound which may occur accidentally during the course of an abdominal section, if united by sutures at once, rarely gives rise to trouble. If, on the contrary, the wound is either lacerated or contused, the advisability of refreshing its edges must be considered, as well as that of providing proper drainage for the escape of urine if the edges do not unite by first intention.

Rupture of the Bladder.—This condition is produced by injury to the lower part of the abdomen when the bladder is distended, and has often occurred from a heavy fall after a drinking-bout. Under these circumstances the rent occurs in the peritoneal surface, most often in a transverse direction. As a complication of fracture of the pelvis, the bladder may be torn in its extraperitoneal surface. In either case the urine escapes, either into the peritoneal cavity or into the cellular tissue of the *cavum Retzii* and abdominal wall, and after a time acute inflammation of these structures sets in. A diseased bladder containing sacculi may rupture on very slight provocation without the occurrence of injury. There may be little or no shock attending the injury, and there may be no signs of peritonitis for many hours.

The **diagnosis** of this condition may afford no difficulty whatever ; or it may be attended with the greatest uncertainty until an exploratory laparotomy has made the actual state of affairs clear. The urine drawn off by catheter is usually more or less mixed with blood : sometimes, after a small quantity has escaped and the flow has ceased, manipulation of the catheter has passed it through the visceral rent, and a large quantity of clear urine or turbid urinous fluid has flowed from the serous cavity. In such a case the end of the catheter may be felt immediately under the abdominal wall. Where doubt exists, it is a good plan, after drawing off any urine in the bladder, to inject the viscus with a known quantity of boiled water, noting its effects and the amount returned. If the quantity collected is the same as that injected, and the bladder is felt to rise up behind and then above the pubes, the viscus is not ruptured ; but if the quantity returned is much less than that injected, and the injection of a pint or more causes no rising up of the bladder behind the pubes, a rent must be diagnosed. If the patient is sure that his bladder was full before the accident, and no urine can be drawn off by a catheter which passes easily into its cavity, a rupture of the bladder should be suspected. Sometimes the presence of fluid in the peritoneum can be made out by percussion, each loin alternately becoming dull as the patient moves from side to side.

Treatment.—In all cases of doubt, if the patient is strong enough to stand it, an exploratory laparotomy should be performed as soon as possible. If the bladder is found ruptured on its peritoneal aspect, the two edges must be brought together by a series of Lembert sutures of fine silk, care being taken to approximate accurately the serous surfaces. The operation is much simplified by the Trendelenburg position.

The peritoneum should be well flushed with boiled water, and the bladder injected in order to ascertain if it is water-tight. The bladder

must not be drained, but a catheter should be passed whenever the patient desires to void his urine.

If the rent is extraperitoneal, means must be afforded for the escape of the extravasated urine by suitable incisions. The surgeon must determine from the circumstances of each case whether it is advisable to drain the pelvic floor by an incision anywhere at the base of the bladder, or to drain the bladder itself through a perineal opening. Whichever plan is adopted, care must be taken to ensure a free exit for the urine as soon as it begins to accumulate in the bladder.

Vesical fistulæ are occasionally the result of foreign bodies having found their way toward the surface of the abdomen. Such openings are very difficult to close unless the bladder be drained, when they not infrequently heal of themselves.

Occasionally communications exist between the bladder and the intestine, giving rise to distressing pain in consequence of the bladder being distended by flatus, which passes out by the urethra. Cystitis speedily supervenes, and, unless the aperture which leads into the intestine can be closed, soon causes death from pyelitis. It is rarely possible to do more than palliate such cases by performing a colotomy.

Cystitis.—Cystitis invariably depends on some source of infection. Infective organisms have often been introduced, either by design or by accident, into the urinary tract without giving rise to any inflammatory change. Horton Smith[1] has demonstrated that typhoid bacilli in the urine produce no inflammatory changes in the urinary tract. In 1892, Pernice and Scagliosi[2] injected various cocci into the blood of animals, and in many instances found them subsequently in the urine, but they did not produce cystitis. As clearly pointed out by Reymond,[3] either the mucous membrane of the urinary tract must be damaged or there must be retention of urine.[4] Given either of these conditions, if septic organisms find their way in, an attack of cystitis is certain to occur. The source of infection is not always easy to determine; oftentimes it is introduced from without by the aid of a foul catheter; sometimes, at any rate, infection takes place from the surrounding organs and tissues. Reymond quotes one instance in which the same organism was found in both the uterus and the urinary tract, the uterus having been infected first and the bladder afterward. The surgeon is unable to prevent infection taking place from the inside of the body, but he can generally prevent it from being introduced through a catheter. He cannot, however, always prevent infection, for in the folds of the urethra the cleanest catheter may find a bacillus and push it onward into the bladder. Before introducing a catheter the orifice of the urethra should be washed with soap and water and cleansed with an antiseptic. The catheter should be of such a nature that it can be boiled without injury; and in the comparatively rare cases where this is inadmissible, it should be soaked previously in some suitable antiseptic fluid. The author generally uses for this purpose a solution of izal, ʒj to Oj, which has the great merit of being a powerful germicide that does not inflict much

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[1] *Med.-Chir. Trans.*, vol. 80, p. 141, 1897.   [2] *Riforma Medica*, No. 98, 1892.
[3] *Ann. des Mal. des Organes genito-urinaires*, p. 253, 1893.
[4] An interesting case affording a very remarkable clinical confirmation of these statements will be found in *St. Bartholomew's Hospital Reports*, No. xxxiii., p. 85, in which cystitis was produced by the Bacillus coli communis during an attack of typhoid fever.

injury on the smooth surface of a catheter nor irritate the urethra and bladder.. The changes which occur in an attack of cystitis are as follows: The mucous membrane seen through the cystoscope assumes a bright-pink color, gradually darkening as the attack advances. Suppuration oftentimes ensues, and occasionally ulceration or even sloughing of a portion of the mucous membrane. If the attack is of long standing, the deeper tissues are invaded, especially if a streptococcus-infection has taken place, and the bladder partially or entirely loses its power of expansion and contraction.

The **symptoms** in the early stages are insidious. At first hardly distinguishable from those of vesical irritability, they rapidly become pronounced. Micturition becomes more and more painful. The accumulation of more than a few ounces of urine gives rise to extreme pain, which is much aggravated by pressure over the pubes or by rectal examination. The urine contains pus, and is usually foul-smelling, ammoniacal, and alkaline.

The constitutional symptoms of fever soon manifest themselves; and if the case is severe, the patient speedily passes into the so-called typhoid condition, and dies as a result of exhaustion. The less severe cases pass into a condition of chronic cystitis, and eventually end fatally by inducing an ascending pyelitis.

The **prognosis** of cystitis depends largely on its cause. The slighter varieties speedily yield to treatment by diluents, low diet, and confinement to a warm room. Such cases, in early life at any rate, are usually a consequence of gonorrhea. If the attack has been produced by a calculus or tumor of the bladder, or by the presence of a stricture, relief of these conditions will speedily arrest the cystitis. Those cases which are due to enlarged prostate are more difficult to deal with: their treatment has been considered under the head of enlarged prostate (p. 551).

Treatment.—The general principles which should guide the surgeon in the treatment of all these cases will have been rendered evident by a consideration of the pathological researches referred to above. The bladder must be kept empty, if necessary by means of a catheter, and washed out with an antiseptic, a few drops of silver nitrate being afterward introduced. If a foreign body or tumor is the exciting cause, it should be promptly removed and free drainage afterward ensured. It must be borne in mind that cystitis cannot long continue without infecting the kidneys; and if treatment by catheter fails to induce a cure, the advisability of operative measures must be considered.

Tuberculous disease of the bladder is in its early stages difficult to distinguish from other affections which are accompanied by vesical irritability. Ulceration of the bladder, with granulating tuberculous patches, is present in the later stages. At an early period, when perhaps vesical irritability and slight hematuria are the only symptoms, an inspection of the bladder with the cystoscope will reveal nothing but a few patches of red mucous membrane, possibly surrounded by some outlying smaller patches, reminding one of the general distribution of the patches in a case of lupus of the face. Such an appearance, when it exists, is almost, if not quite, pathognomonic of the disease. The presence of tubercle-bacilli is the only absolute proof of the disease. Tuberculous mischief of the urinary tract may always be

suspected when the surgeon is called to treat a case of vesical irritability of unexplained cause in a patient between the ages of seventeen and forty. The presence of tuberculous foci in other parts of the body, especially if there are nodules in the testicles, prostate, or vesiculæ seminales, or a history of tubercle in other members of the family, will go a long way toward confirming the diagnosis; and the presence of tubercle-bacilli in the urine or the existence in the bladder of the characteristic ulcers alluded to above will settle the diagnosis.

The **symptoms** of a well-marked case of this disease are often very distressing. The vesical irritability and pain are intense, and the urine is mixed with blood and pus.

The **treatment** of these cases is fraught with considerable difficulty. Some seem to be benefited by change of air, cod-liver oil, tonics, etc.; while in others local treatment is of considerable assistance, at least in alleviating their symptoms. An emulsion of iodoform in olive oil injected daily into the bladder and allowed to remain has in my experience often proved beneficial, especially if the bladder is well washed out previously. Cystotomy rarely proves advantageous, as the tuberculous granulations gradually invade the edges of the wound; but it sometimes gives a patient repose which he would be otherwise unable to obtain (see Tuberculous Disease of the Prostate).

Stone in the Bladder.—Excluding those rare forms of stone, the cystine and the crystalline phosphatic calculus, three or four varieties

FIG. 301.—Cystine calculus removed by suprapubic lithotomy from a female twenty-nine years of age. Symptoms of ten days' duration; weight, 1569 grains (Warren's case).

are commonly met with. Uric-acid and uratic calculi are by far the commonest; the oxalate of lime or mulberry calculus is rarer, and the phosphatic and mixed calculi rarer still. Those calculi in which phosphatic layers occur or which are formed wholly of amorphous phosphates are due to some septic condition of the urinary tract, and, as a rule, have inflicted some amount of damage on it. Uric-acid or oxalate calculi may remain for a long time in the bladder, and yet, when removed, leave it in a perfectly healthy condition. They are usually formed in the kidneys, and find their way into the bladder later, where they rapidly increase in size.

Such calculi, especially those of the uric-acid variety, are commonly

found in the bladders of men over fifty years of age in easy circumstances, who often take too much food and drink and too little exercise. Such persons are liable to gout, and, as a rule, get rid of their surplus uric acid in the form of gravel of a reddish color, which is deposited from their urine. If, however, there is sufficient irritability to cause the secretion of much mucus or other cementing material, a crystalline calculus is started, and, once formed, grows steadily by accretion. In children of the poorer classes stone is more prevalent, their bad food and unhealthy surroundings tending to promote the disease.

The **symptoms** of stone in the bladder are (1) pain referred to the corona glandis or clitoris at the end of micturition, and made worse by rough movement of the body; (2) frequency of micturition, worse during the day than the night; (3) hematuria, the blood coming with the last few drops of urine; the hemorrhage is likely to be excited by a rough jolting ride or drive. The urine is often turbid from cystitis.

The symptoms of this affection differ considerably at the two extremes of life, and the reason for this is obvious. In children the bladder is small and runs up into the abdomen, and the urethra forms its most dependent part. The life they lead, also, is one of constant
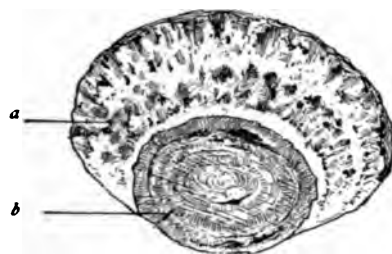
FIG. 302.—Uric-acid calculus; the lower half was embedded in a sacculus; the upper half, being exposed to the urine, became coated with phosphates: *a*, phosphatic exterior; *b*, uric acid.

FIG. 303.—Mulberry calculus.

activity; and, lastly, the form of stone to which they are specially prone is the mulberry calculus. Hence the irritation produced by a stone in the bladder of a child is far greater than that which occurs in the adult. As age advances the prostate increases in size, and the lowest part of the bladder, instead of being situated at the urethral orifice, is found behind the prostate (the so-called retroprostatic pouch). In this situation a stone finds a ready resting-place, and its possessor is often scarcely conscious of its existence. It is only perhaps after an extra good dinner or some active exercise, possibly on horseback, that he experiences some discomfort about the end of his penis, passes perhaps a little blood, and complains generally of urinary irritability. In this condition he consults a surgeon, his bladder is sounded, a stone discovered and, as a rule, removed by lithotrity at a single sitting.

Calculus due to Foreign Bodies.—A piece of bone, as a result of either pelvic fracture or hip-joint disease, may find its way into the bladder. Hairpins and pencils or ends of catheters or other foreign bodies may be introduced into the bladder, become encrusted with phosphates, and be subjected to lithotrity with only partial success. If the foreign body is of considerable size, it is obvious that lithotomy will prove far more

suitable than crushing, which is very liable to leave the nucleus untouched and unremoved. No foreign body should ever be permitted to remain in the bladder: sooner or later it will give rise to calculus, whilst an early removal will prevent such an occurrence.
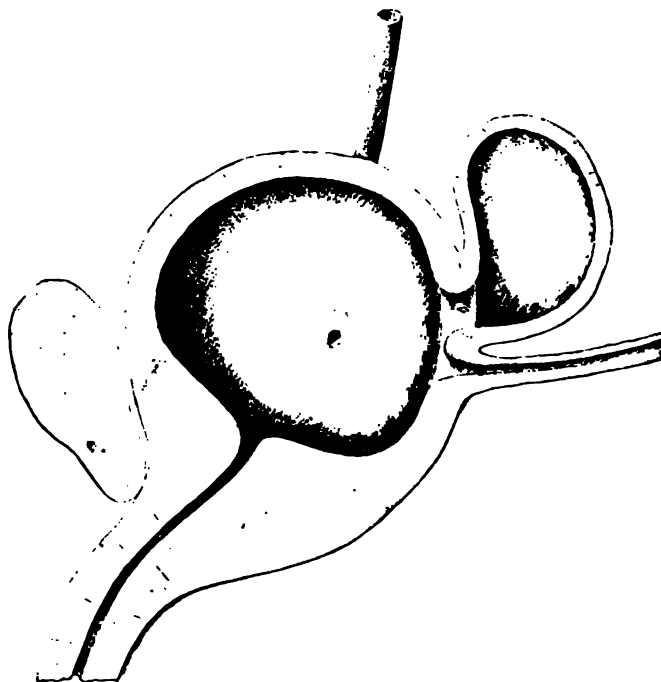
FIG. 304.—Sacculus of the bladder; slightly diagrammatic, in order to show the relative position of the sacculus and ureters.

Mode of Examination of the Bladder.—This subject has already been dealt with under the head of Exploration of the Urinary Tract (see page 535).

Operations.—The operations that are now in general use for the removal of calculi are (1) suprapubic lithotomy; (2) lateral lithotomy; (3) lithotrity;[1] (4) perineal lithotrity.

The old operation of *median lithotomy* it is unnecessary to discuss. It is applicable only to small stones, and these are preferably removed nowadays by crushing. Where, however, one has to deal with a large stone in an old man, where a lengthy crushing-operation is inadvisable, the method of removal by perineal lithotrity will be found of considerable service. Reginald Harrison's name is closely associated with this method of procedure. On one occasion a stone weighing over 3 ounces was broken up by him, so as to admit of easy removal, in less than five minutes. There is, the author thinks, a

[1] The author prefers the use of the term "lithotrity" to the more cumbrous one litholapaxy, which was originally used when lithotrity at a single sitting had not obtained general acceptance; now that this method of operation is the only one employed, there is no longer any doubt of the propriety of employing for it the term lithotrity.

considerable future for this mode of operation, to judge from the results it has already yielded.

The *lateral operation* is almost as little employed as the median, and will probably be completely abandoned.

For the vast majority of calculi, then, the surgeon has the choice of lithotrity or suprapubic lithotomy.

When a calculus is small and the bladder is healthy lithotrity yields the best results. Calculi of the size of a walnut may be removed and the patient be practically well at the end of forty-eight hours. But there is a limit placed on lithotrity by the size of the stone to be removed. Speaking generally, there are few stones above 2 inches in their long diameter which can be removed with advantage by the lithotrite. When this size is exceeded a large and powerful lithotrite is essential if the stone is to be quickly disposed of. The patient has probably suffered from its effects for a considerable time, and his bladder is not in a healthy condition, as it has suffered from one or more attacks of cystitis. If these attacks have been severe and repeated, a strong case will be made out for suprapubic lithotomy; and the case will be strengthened if there is reason to suppose that some further vesical complications may be present. It may be that a sacculus conceals a second stone, or that a deep retroprostatic pouch makes removal by lithotrity a difficult proceeding. If any such complication is present, and the patient is robust and healthy for his age, the suprapubic operation is to be preferred, as it affords an easy mode of inspecting the interior of the bladder and an effectual one for removal of those conditions which have contributed to promote its unhealthy condition. At the same time it must be borne in mind that stones considerably larger than 2 inches in their longest diameter have been successfully removed by lithotrity. Such calculi, however, should be so removed only by one who has had much practice, and he will be guided by his own experience, and not swayed by the practice of his average contemporaries.

Suprapubic Lithotomy.—When the revival of this operation took place some fifteen years ago, the almost universal custom was to distend the rectum with a rubber bag (Petersen's) in order to elevate the bladder out of the pelvis and render its base more readily accessible. Recent experience has taught us that the bag is usually unnecessary and in some cases harmful, as it has a tendency to cause congestion of the neighboring veins and so increase the bleeding which occurs when growths are removed from the interior of the bladder. If the operator decides to make use of the bag, it should not contain more than about half a pint; and, provided this limit be not exceeded, there is no danger of injuring the rectal wall. An instrument of some kind should be introduced into the bladder, preferably a silver catheter, which will serve as a passage for the water (about 10 ounces) that requires to be introduced for its distention and as a guide during the operation. It is best to introduce the catheter first, then distend the rectum, and after that the bladder. The incision is made in the middle line, about $2\frac{1}{2}$ inches in length, cutting through everything until the subperitoneal fat is reached. In all probability there will be no vessels that need to be secured. As a rule, there is no difficulty in identifying the

parts, especially when a silver catheter is in the bladder and the bladder itself is distended. The peritoneum is sometimes seen as a bulging pouch at the upper portion of the wound. If so, it must be pushed upward out of the way and the bladder-wall exposed. A sharp hook is useful to hold the upper part of the bladder. When this has been inserted the bladder-wall should be quickly incised, or the mucous membrane will not be divided, and may be stripped up by the finger as it is being introduced into the interior. A silk loop should next be inserted on each side of the incision, for retraction. The stone can be removed by the fingers, forceps, or scoop, and the interior of the bladder, including the prostatic urethra, carefully explored and further dealt with if necessary. If a tumor is present, it should be removed, if possible, together with the mucous membrane at its base, and the sides of the incision united by suture. This plan is obviously not applicable in epithelioma. Treatment in such a case can only be palliative.

After-treatment.—If the bladder is perfectly healthy and all bleeding has been arrested, immediate suture of its edges can be employed with success; but it should never be attempted where such conditions do not obtain. A full-size drainage-tube should be inserted after the upper end of the wound has been closed by sutures. The dressing will need frequent changing, to prevent bedsores. A simple absorbent pad is all that is required. The drain can usually be removed at the end of forty-eight hours.

Lateral lithotomy, now rarely resorted to, is performed as follows: The patient is secured in the lithotomy position, and a staff, grooved

FIG. 305.—Lithotrite.
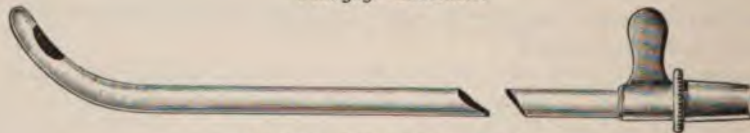
FIG. 306.—Evacuating-catheter.

on the left side, introduced. When it has been placed in a suitable position by the operator it is handed to an assistant, who holds the scrotum and its contents out of the surgeon's way. The knife, entering behind the scrotum, is rapidly brought down upon the groove of the staff by the first incision, and then continued along it until the prostate is reached. This organ is deeply incised on its left side below, and the left index-finger of the operator introduced into the interior of the bladder. Then, and *not till then*, does he give directions for the withdrawal of the staff by his assistant. The stone is removed by forceps or scoop. Severe hemorrhage occasionally results from wounding of the artery of the bulb or other vessel. If it cannot be secured in the ordinary way, bleeding is usually arrested either by what is known as a petticoat plug or by a rubber bag which is introduced into the wound and afterward distended. It contains a tube in its interior through which the urine passes.

Perineal Lithotrity.—In this operation the patient is placed in the same position as for the lateral operation. A staff with a median groove is employed, and an incision is made into the membranous urethra behind the bulb. The prostatic urethra is then dilated with either the finger or forceps, or preferably by a series of conical steel bougies, until it has attained a diameter of about $\frac{1}{2}$ or $\frac{3}{4}$ inch. When this has been accomplished a pair of powerful crushing-forceps are introduced, and the fragments removed by means of an evacuating-catheter of suitable size. The *after-treatment* of such a case is exceedingly simple, and consists merely in keeping the wound clean. The patient, if old and feeble, may with advantage be allowed to sit up in an arm-chair at the end of forty-eight hours.

Lithotrity.—Before undertaking this operation the surgeon should be provided with two or three lithotrites, varying in size from No. 10 or 12 to No. 16 or 18. If the pa-
tient is a child, probably a No. 6 will be required. Two evacuators (Fig. 307) and some half a dozen evacuating-catheters are also required. The bladder should contain some 4 or 5 ounces of water when the lithotrite is introduced. An instrument with a full fenestrated blade should be employed. It should be as large as can be conveniently introduced into the bladder. The patient's pelvis should be slightly raised, so as to permit the stone to drop backward away from the urethral orifice.

If the stone is not encountered at once, the lithotrite should be allowed to remain perfectly motionless for a few seconds, after which

FIG. 307.—Lithotrity evacuator.

the small blade should be quietly withdrawn and as quietly replaced a few seconds later. In many cases the calculus will be thus grasped at once. If this is not the case, the lithotrite should be turned slightly to the right or left, and the above described maneuver repeated. If it still eludes the grasp of the lithotrite, it must be searched for all over the bladder. If the prostate is at all enlarged, it will likely enough be found in a retroprostatic pouch, and the lithotrite will perhaps require to be reversed in order to grasp it. When once the stone is fairly grasped the screw must be gradually turned so as to fix it between the blades, and by gently exercising a little force the stone will soon yield. The various fragments are seized one by one in a similar fashion. After a few minutes' work in any given bladder the operator will find that he catches the fragments almost intuitively. As soon as the bladder seems so full of débris as to impede the finding of fragments the blades must be screwed well home and the instrument withdrawn. If by any mischance the blades should have become bent or so jammed that removal is impossible without damage to the urethra, median lithotomy must be performed and the fragment dislodged by

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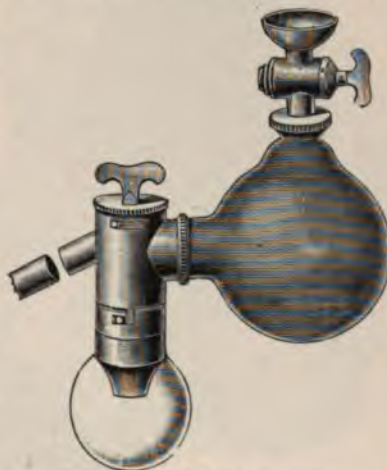
the finger.   Such an accident, however, is almost impossible with the fully fenestrated blades that are now almost universally employed.

A good-sized evacuating-catheter is introduced as soon as the lithotrite has been withdrawn, and the evacuator filled with sterilized water is attached.   A small part of its contents is gently thrown into the bladder and allowed slowly to return.   This process is repeated until all the fragments that are small enough to pass have been withdrawn. The lithotrite is again introduced and more fragments crushed and subsequently evacuated.   After a little practice it is not difficult to recognize the characteristic sound produced by a small fragment which is just
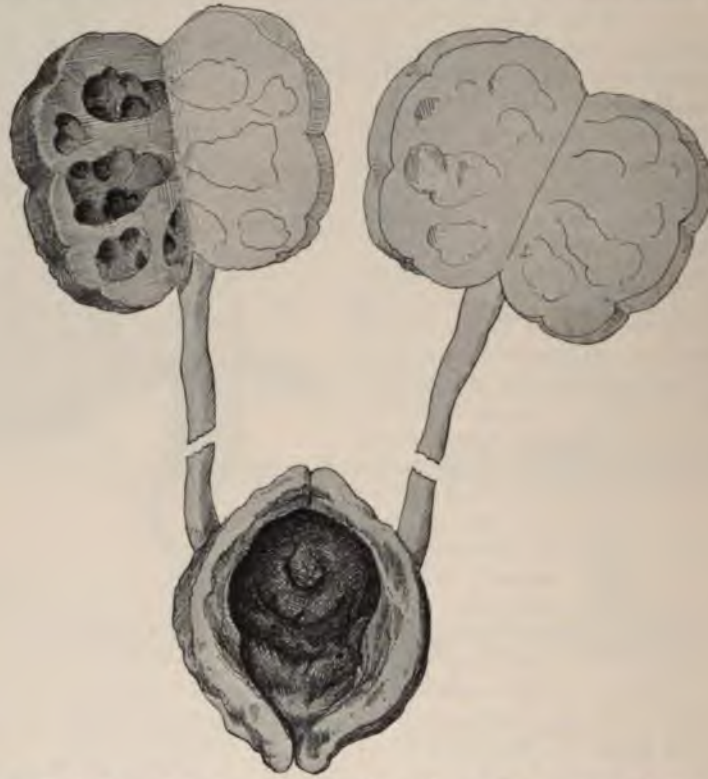
FIG. 308.—Epithelioma of the base of the bladder, with ascending pyelitis and dilated ureter
(St. Bartholomew's Hospital Museum).

too big to enter the evacuating-catheter when it impinges on its open end.   No other test is so delicate for enabling one to ascertain if every fragment has been removed.   It is important to bear in mind, especially when operating on children, that the fewer the number of times that instruments require to be introduced during the course of an operation the better.   Each introduction causes a certain amount of bruising and swelling of the urethral mucous membrane; and the operator will sometimes find, as he approaches the end of a long operation, that the instrument which slipped in easily enough at first works with consider-

able difficulty later on. Occasionally resort must be had to a smaller instrument before the operation can be completed.

The *after-treatment* is simple enough. Washing out of the bladder is rarely required, unless it has been affected with cystitis previously. If the patient does not pass urine, overdistention of the bladder must be guarded against by the timely use of the catheter. The patient is usually able to leave his bed by the fifth or sixth day. If cystitis should occur, it must be treated in accordance with the ordinary rules.

Tumors of the bladder are not of common occurrence. They present two main varieties: epithelioma (Figs. 308, 309), which occurs chiefly at the decline of life; and villous growths (Fig. 310), which are

FIG. 309.—Epithelioma infiltrating the bladder-wall.   FIG. 310.—Villous tumor and enlarged prostate.
(St. Bartholomew's Hospital Museum.)

usually found at an earlier age and are non-malignant. Other growths, such as sarcoma, myoma, etc., can be regarded only as clinical curiosities: they usually occur in children. *Epithelioma* is by far the commonest form of tumor met with. Nearly all bladder-growths are situated in the neighborhood of the trigone and ureters.

Symptoms.—It is rare that the presence of a bladder-tumor is even suspected until hemorrhage supervenes. As a rule, when the patient is questioned he will admit that he has noticed a small amount of blood in his urine on several occasions. It caused him no inconvenience, passed away in a few hours, and he ignored it. A few weeks or months later a second attack supervened, which passed off almost as suddenly. Perhaps the third or fourth attack may prove somewhat more severe and lasting, and he seeks the advice of the surgeon, who will elicit from him that his urine passes quite clear at first, and only becomes blood-stained toward the end of the act of micturition. The blood is bright in color and not altered in character when it passes.

Such are generally the early symptoms of an attack of hemorrhage due to vesical growth. Soon, however, the urine is loaded with blood, which is perhaps darker in color because it has accumulated in the bladder before it is passed. Then cystitis supervenes, with all its distressing symptoms, sepsis ensues, and death terminates the scene. Sometimes, worn out by excessive loss of blood, the patient dies of hemorrhage. Pain may be present or not, but usually depends rather on the cystitis than the tumor, unless the growth is situated so near the vesical orifice that it is caught there during the act of micturition. Cases of epithelioma are usually to be distinguished from those of villous tumor by the great pain suffered, by frequency and difficulty in micturition, and by foul urine.

The **diagnosis** of bladder-growth is not always easy. If the hemorrhage is excessive, it may easily be confounded with renal hematuria. The exact nature of the growth can rarely be determined unless a fragment is discovered in the urine or the interior of the bladder is examined by the cystoscope. By this means many cases are diagnosed and treated early that were formerly subjected to expectant treatment until there was nothing to expect but a fatal issue. It is, however, quite useless to employ the cystoscope during an attack of hematuria. With a finger in the rectum and the other hand pressed well down behind the pubes, particularly if the patient is anesthetized, many bladder-tumors can be felt.

The **treatment** will depend largely on the results of the cystoscopic examination. If the growth prove to be villous and does not infiltrate the bladder-wall, a suprapubic cystotomy should be performed and the tumor completely removed. If possible, the base should be cauterized by a galvanocautery, or a small portion of the mucous membrane of the bladder adjacent to its attachment excised and the edges united by means of a fine suture. Occasionally some trouble is experienced from bleeding. This must be arrested by hot water or pressure with a sponge, or by the cautery. In women it is occasionally possible to remove such growths through the dilated urethra. As a rule, no attempt should be made to seize such growths, either in the male or the female, through a perineal opening, as it is usually impossible to extirpate them with any certainty by this method. The operator is liable either to leave a portion of the growth behind or to make a hole through the bladder-wall if he endeavors to remove the base. If the tumor is known to be an epithelioma infiltrating the bladder-wall, extirpation is probably out of the question, and a permanent drain affords the only means of preventing the inevitable suffering that must ensue if no operative measures are attempted. In such a case the suprapubic operation may be performed in two stages, making an incision into the peritoneum and stitching the bladder to the abdominal wall on the first occasion. The opening into the bladder can be made a few days later, without pain. If, however, the operator is in doubt whether removal is possible, the ordinary suprapubic operation should be performed and the wound kept permanently open, if necessary, by means of a suitable tube (for details of the suprapubic operation, etc. see p. 559).

CHAPTER XVIII.

SURGERY OF THE URETERS.

Anatomy.—The ureters, the excretory ducts of the kidneys, have the duty of carrying the urine from those glands to the bladder. They consist of tubes of mucous membrane surrounded by circular, spiral, and longitudinal muscular fibers. Their length was found by W. M. Tanquary to vary from 25 to 31 cm. (10 to 12¼ inches); Luschka gives the length as 27 cm. (10¾ inches); and Funke estimates the length of the left ureter as 26 to 34 cm. (10¼ to 13½ inches), while the right, he states, is some centimeters less. It is convenient to speak of the ureter as being divided into an abdominal and a pelvic portion. The course of the ureters is of great surgical import. The tube, leaving the kidney, runs downward and inward, hugging the vertebral origin of the psoas muscle. At the iliac vessels, often somewhat before reaching them, it begins to turn outward. After having crossed the iliacs the duct bends outward, in a certain degree following the lateral wall of the pelvis, until it finally turns in a tolerably sharp curve toward the base of the bladder. This last curve varies with the distention of the bladder. The relations of the ureters are thus described by Funke:

" In the abdomen, the right ureter lies at first behind the duodenum, at the point where the *pars descendens* passes over into the *pars horizontalis;* later, it lies to the outer side of the vena cava inferior. The left ureter runs close to the spermatic vein, outside of it. The left ureter crosses the vessels at a somewhat higher level than the right, and runs below the peritoneum or, better expressed, the mesentery of the sigmoid flexure, always where the intersigmoid fossa is found; and when the peritoneum is incised in this groove the ureter is laid bare. The right ureter crosses the point of division of the common iliac artery into the external iliac and the hypogastric, while the vessels, so far as they are of importance (gluteal, sciatic), are directed backward and outward. The ureters finally pass forward and toward the median line to the bladder. The ureter lies behind the uterine artery, between it and a rather large vein originating in the uterine plexus and running to the hypogastric vein."

The ureters are not passive, patent tubes, but active muscular structures, which carry the urine, a drop or two at a time, to the bladder under positive pressure, just as the esophagus carries fluids to the stomach. Waves of contraction are associated with the passage of these drops.

The diagnosis of ureteral diseases is often closely associated with that of renal maladies, as we shall have occasion to show. Subjective signs of ureteral disease are often wanting; but when obstructive lesions are present, especially when stones are passing down the

ureter, pain, due chiefly to distention, is felt radiating down to the bladder and generative organs. In the uncertainty necessarily felt when subjective signs are not determinative, we turn naturally to those more direct methods which are the outcome of very recent study and experimentation. It is true, palpation occasionally gives valuable information; but only in those diseases or conditions in which the duct has been altered in size and form or contains a solid body.

The pelvic portion of the ureter is, of course, most accessible to examination. The simple cystoscope of Grünfeld, slightly modified, has been used by Pawlik and Kelly to study the vesical extremity of the duct in the female, and by Kelly that in the male also. For general observation the writer much prefers the electric cystoscope of Nitze, which enables one to examine the mucous membrane under natural pressure-relations, in the element to which the bladder is accustomed, and at the same time to study all parts of the vesical wall.

Sounds and catheters may be passed into the ureters, in order to determine their caliber and the condition of their walls or to withdraw the urine from each kidney separately by the use of the instruments of Pawlik, or Kelly's modification of them, or by the use of the electric cystoscope of Nitze or Casper.

Kelly describes the procedure for women[1] as follows: "The following instruments are required: A good light and a head-mirror; a urethral dilator; a speculum with an obturator; a suction-apparatus to empty the bladder completely; a pair of long mouse-tooth forceps; a searcher for discovering the ureteral orifice.

"A general anesthetic is not necessary, unless the patient is so nervous that she will not submit to any kind of an examination. For this reason it is sometimes of advantage to use ether or chloroform during the first examination, which is apt to be more prolonged than the subsequent ones. If the urethra requires any dilatation, a drop of a 10 per cent. solution of cocain painted on its external orifice, or a piece of cotton wrapped on an applicator, saturated with a 4 per cent. solution and laid just inside the orifice, will be sufficient to blunt the sensitiveness.

"Immediately before examination the patient must pass water, preferably in the standing position. In spite of this effort to empty the bladder completely, a little residual urine almost always remains behind. If the examination is delayed ten or fifteen minutes, 5 or 10 c.c. (1.35 to 2.71 fluidrams) will be added.

"The urethral orifice is now dilated by using a conical dilator, blunt at the point, 72 mm. ($2\frac{7}{8}$ inches) long, and 16 mm. ($\frac{5}{8}$ inch) in diameter at the base and 4 mm. (0.16 inch) at the point. This is covered with vaselin and, with a screw-like movement, gently bored into the urethral orifice. Two or three gentle movements, holding the dilator poised between thumb and forefinger, will be sufficient to carry it in as far as the No. 10 mark on the scale on its side. This indicates a dilatation of 1 cm. (0.4 inch) in diameter, sufficient for all ordinary purposes of investigation of the bladder, treatment of its surfaces, and catheterization of the ureters. In many cases, particularly in women who have borne children, the orifice needs no dilatation to permit the introduction of a speculum of this size. The utmost damage done by the dilatation is a slight superficial injury to the mucous surface of the posterior margin of the urethra, which never requires attention.

"The most convenient and universally applicable position is the knee-breast posture, with the chest as close to the table as possible, and the back well bent in. Frequently a more satisfactory posture is the knee-breast, with the patient squatting a little backward, so that the buttocks are in a position directly over the calves of the legs or the ankles, instead of being vertically over the thighs. The speculum is now taken in hand, and held with the thumb pressing upon the handle of the obturator. The point of the speculum is placed upon the orifice and pushed up through the urethra into the bladder in a direction describing a gentle curve around the under surface of the symphysis. On withdrawing the obturator, air rushes at once into the bladder, distending it with an audible suction-sound.

[1] The method is scarcely practicable in the male on account of the length and curvature of the urethra.

"The examiner wears one of the ordinary head-mirrors used by laryngoscopists, and by its means reflects a light from an electric lamp resting on a towel on the sacrum of the patient (if in the knee-breast position), through the speculum into the bladder. By turning the speculum to the right or left about 30 degrees, with its end projecting 1 cm. (0.4 inch) into the bladder, the right and left ureteral orifices can be brought successively into view. The ureteral orifice usually appears as a little slit, about 3 mm. (0.12 inch) long, placed transversely with a slight horseshoe-shaped elevation around it, open on the inner side. If the observation is continued for a minute, a little jet of urine will be seen to spurt out of the ureter for two or three seconds.

"To introduce the catheter, the ureteral orifice is brought to about the center of the field of the speculum, and the mirror and light are adjusted so that the head of the observer is not in the way as he introduces the catheter into the speculum and slides it on until its point rests in the ureteral slit. On pushing it in a little, the sides of the opening separate, and it appears as a hole, with the catheter lying in one side of it. The catheter must now be pushed out gently toward the side, stopping at once if the slightest resistance or obstruction is met."

Casper's apparatus consists of an electric cystoscope, with a long groove in its wall, in which lies the catheter, protected by a sliding cover

FIG. 311.—Casper's uretercystoscope.

(Fig. 311). The instrument is introduced into the bladder, which is distended with 150 to 200 c.c. (5 to 6.8 fluidounces) of water. The electric light being turned on, the ureteral openings are sought for by observation through the optical part of the apparatus. Into each of them, in turn, the ureteral bougie or catheter is introduced under ocular observation, by pushing forward the catheter from its slit. Once the catheter is in place, it may be left there as long as desired, by removing
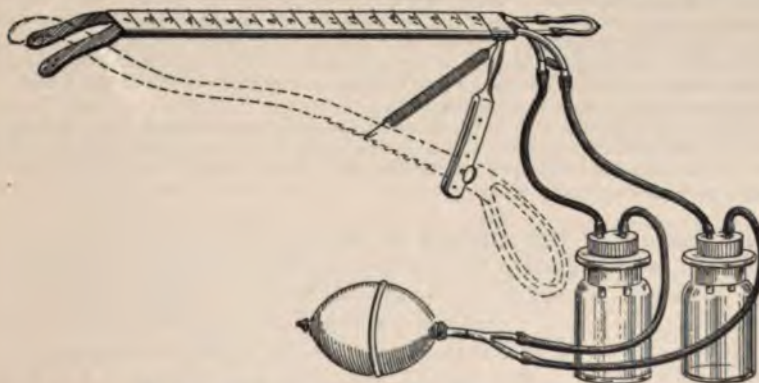
FIG. 312.—Harris's instrument for obtaining urine separately from the ureters.

the metal case from around it. These methods are of prime importance where the caliber and walls of the ureter are to be studied.

Harris's Method.—For the study of the condition of the ureters, as inferred from the composition of the unmixed urine derived from each kidney separately, the idea of Neumann, as wrought out practically by

M. L. Harris, is most valuable. Describing his instrument (Fig. 312) and the method of using it, Harris says:

"It consists of a double catheter, each being separate throughout, but both being enclosed in a common sheath throughout its shaft or straight portion, thus giving it the appearance of a single flattened tube. Each catheter is separately movable about its longitudinal axis within the sheath. . . . In the flattened surfaces and the lateral portions of the semicircular surfaces are a number of small perforations. The distal extremity of each catheter is round and curved in the same plane as the proximal extremity, forming about a quadrant of a circle, the same as the curved end of an ordinary male sound. The curves of the two extremities being in the same plane, the distal end will always indicate accurately the exact direction of the proximal end. . . . The distal extremity of each catheter is connected by means of a short piece of rubber tubing with a separate glass vial. The corks of the vials are doubly perforated, and each vial is finally connected by a piece of rubber tubing with a single rubber exhaust-bulb (Fig. 312.. There is a metal lever, about 29 cm. 11½ inches, in length, with a handle at one end, the opposite extremity being suitably curved and flattened laterally. This lever is provided with a single perforation near the handle, is flattened on its sides, and notched along its lower border. A detachable curved forked metal piece connects the catheter with the lever when in use. This connecting piece is provided with a spiral spring arranged to catch in the notches on the under surface of the lever.

"The instrument is used in the following manner: The patient, male or female, is placed comfortably on a table in the ordinary lithotomy-position, the hips being as high as the shoulders. The instrument, with the flattened surfaces in contact, so as to form practically a single catheter, is introduced into the bladder in the ordinary manner. The connecting piece is attached. The lever passing through the forked connecting piece is now introduced into the vagina in the female, the rectum in the male. The fork holds it in the midline. When introduced the proper distance, as indicated by the perforation in the lever coming opposite the perforations in the forked piece, it is fastened by passing the pin in the forked piece through the perforation in the lever. The instrument in the bladder is now opened by slowly and gently rotating each catheter about its longitudinal axis until each proximal end, as indicated by the distal end, is directed outward and backward. The angle subtended posteriorly by the ends of the catheters should be about 100 to 110 degrees. They are held in this position by the small spiral spring. In opening this way, the end of the lever within the vagina or rectum passes up between the ends of the catheters, so as to form a septum extending longitudinally along the base of the bladder. The end of the lever is held snugly in between the diverging ends at the catheters by the spiral spring catching in the notches on the under surface of the lever. It will be seen now that the end of each catheter in the bladder occupies the bottom of a little pocket, the pockets being separated by a perfect septum or water-shed. The ureters open, one on either side of the water-shed, near the base of the declivity in the immediate vicinity of the respective ends of the catheter. By producing a very slight exhaustion of the air in the vials by means of the bulb, the urine, as fast as it escapes from the ureters, drops directly into the ends of the catheters and flows at once into the vials, right and left respectively.

"Before attaching the vials to the catheters, the little pockets in the bladder may be thoroughly irrigated and cleansed, if thought desirable, by connecting an irrigator with the short, straight tip on the catheters, closing the other opening with the finger, thus washing through one catheter and out of the other."

Anomalies of the ureters are not rare, but they are uncommon. The ureter is occasionally double, the two ducts often opening normally in the bladder. Kolisko has shown that with one tube opening at the normal site, the other coming from the same kidney may open by a narrow slit at a point within the grasp of the sphincter vesicæ, so that a sacculation of the ureter results from the constriction. The ureter, when single, may also open within the grasp of the sphincter, in the prostatic urethra, or in the vas deferens, ejaculatory duct, or seminal vesicle. In the female the ureter may open into the vestibule, the urethra, or the vagina. The lower end of the ureter may be congenitally closed or it may end in the rectum. In exstrophy of the bladder the ureters open upon the everted mucous membrane upon the abdominal wall. The recognition of these conditions is, as a rule, not difficult;

the cure of the condition (except in exstrophy of the bladder) usually involves the implantation of the ureter into the bladder.

Wounds of the ureter tend to heal rapidly, inasmuch as the tissue of the duct is well supplied with blood and is composed of cells capable of rapid proliferation. The ureter has even been separated from surrounding structures for 8 cm. ($3\frac{1}{4}$ inches) without causing gangrene, a circumstance due to the fact that a long artery of narrow caliber attends the ureter, supplying it with blood. The regular, wave-like contractions of the ureter tend to separate wound-surfaces, however, and often compel the edges to unite by granulation. The urine has the same effect. Drainage of the wound and of the loose tissues about the ureter is of importance, especially when infection has occurred.

Longitudinal wounds heal readily, especially if rectilinear, provided they are uncomplicated and drained. Since granulations form of necessity, and epithelial cells must migrate over them, strictures are not likely to occur in longitudinal wounds. The *treatment* of such wounds in aseptic cases may be by the use of fine catgut sutures passed transversely through the outer connective-tissue coat; but one must remember that such sutures are likely to diminish the caliber of the tube somewhat, and therefore should be used with caution. Usually drainage alone is all-sufficient. It should be extraperitoneal always. The extrapelvic ureter should be drained posteriorly; while the pelvic portion may be drained in this direction, or by way of the vagina in the female or the perineum in the male.

When longitudinal ureteral wounds are complicated by peritoneal injury, as when such wounds occur during laparotomies, the technic is as follows:[1]

"Keep intestines and other viscera out of the way with suitable compresses. Trendelenburg's position is indispensable in work within the pelvis. Expose the injured ureter, and, if desirable and feasible, have an assistant support or elevate the tube. Apply the sutures as already suggested. Remove from the ureter the pressure and tension of the assistant's forefingers. If, after several waves of contraction have passed down the ureter, indicating the passage of the same number of drops of urine, there is observed to be no leakage, the peritoneum must be carefully adjusted about the ureter with accurate sutures. This must be done for three reasons: First, the peritoneal coat immediately reinforces the line of sutures, steadies the ureter, and assists in preventing leakage. Secondly, the peritoneal membrane very quickly unites to surrounding structures, so that in a few hours the ureteral wound is provisionally healed. Thirdly, the rapid regeneration of the histological elements of the peritoneum insures the speedy definitive healing of the peri-ureteral wound, so that the production of granulation-tissue is limited to the utmost, and scar-contraction is less likely, in the sequel, to interfere with the lumen of the tube. The envelopment of the ureter in peritoneum may be accomplished by either of two methods. The first and best is by lifting the tube gently into the cavity of the peritoneum, drawing the serous membrane carefully behind the ureter, and stitching it in a position permanently to enclose and protect the vessel.

[1] Practice in such operations may readily be obtained by operating upon the ureters of dogs.

Secondly, the ureter may also be involved in a completely detached fold of omentum, which is loosely attached by a stitch to the connective tissue about the ureter. This method is obviously less secure than the first, since the omentum is deprived of its blood-supply. Tuffier complicates his technic, which does not include my suggestion of a peritoneal covering, by the temporary ligature of the ureter on the renal side of the wound, to prevent the escape of urine until the row of sutures is complete. Since the normal urine is not capable of setting up peritonitis or of causing suppuration, this precaution is unnecessary and undesirable. It must be carefully observed, however, in the rare abdominal operations upon the ureter in which the urine is known to be septic."[1]

Longitudinal wounds often have to be made in order to afford access for exploration, to remove stones, and to correct stenoses.

Transverse wounds of the ureter carry with them the possibility of stricture-formation. When aseptic transverse wounds are treated by open methods they may require suturing, which, the writer thinks, should be carried out by a plastic procedure, in case the wound involves one-third or more of the circumference of the tubes, as follows:

" Make two longitudinal incisions with small scissors in the ureter, beginning at the middle of the wound to be closed. These incisions should be equal in combined length to twice the transverse diameter of the tube. Round off the sharp angles of tissue with the scissors and suture longitudinally, with the object of producing a very wide instead of a very contracted lumen. Scar-contraction cannot now reduce the caliber of the tube sufficiently to interfere with the passage of urine. If this operation has to be performed within the peritoneal cavity, the ureter should be protected, after the manner described for longitudinal wounds, by drawing about it a fold of peritoneal membrane."

Complete transverse wounds of the ureter at the renal extremity of the duct may be treated by direct suture of the divided structures, after slightly splitting the ureter to lengthen the wound and prevent scar-contraction. At the vesical extremity the ureter may be readily implanted into the bladder, as has often been done. For complete transverse division the writer has devised a method of reunion which he thus described:

1. Ligate the lower portion of the tube $\frac{1}{8}$ or $\frac{1}{4}$ inch from the free end. Silk or catgut may be used. Make, with fine, sharp-pointed scissors, a longitudinal incision twice as long as the diameter of the ureter, in the wall of the lower end, $\frac{1}{4}$ inch below the ligature (Fig. 313).

2. Make an incision with the scissors in the upper portion of the ureter, beginning at the open end of the duct and carrying it up $\frac{1}{4}$ inch. This incision insures the patency of the tube.

3. Pass two very small cambric sewing-needles, armed with one thread of sterilized catgut, through the wall of the upper end of the ureter, $\frac{1}{8}$ inch from the extremity, from within outward, the needles being from $\frac{1}{16}$ to $\frac{1}{8}$ inch apart, and equidistant from the end of the

[1] Quoted from article by the writer, *Journal of the American Medical Association*, Dec. 16 and 23, 1893.

duct. It will be seen that the loop of catgut between the needles firmly grasps the upper end of the ureter.

4. These needles are now carried through the slit in the side of
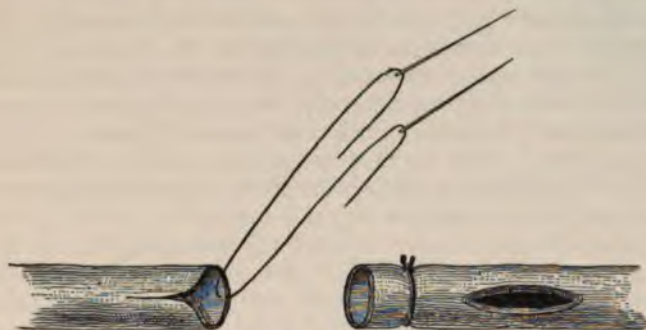
FIG. 313.—Uretero-ureterostomy (Van Hook's method). The needles have been introduced into the wall of the renal portion of the ureter. The end of the vesical portion of the tube has been ligatured and a slit made in its wall.

the lower end of the ureter into and down the tube for $\frac{1}{2}$ inch, where they are pushed through the wall of the duct side by side (Fig. 314).

5. It will now be seen that the traction upon this catgut loop pass-

FIG. 314.—The needles, carrying the traction-suture attached to the renal portion of the ureter, have been passed into the slit in the wall of the vesical portion, carried down a short distance, and pushed out through the wall.

ing through the wall of the ureter will draw the upper fragment of the duct into the lower portion. This being done, the ends of the loop are tied together securely, and, as the catgut will be absorbed in a few days, calculi do not form to obstruct the passage of the urine.

FIG. 315.—By means of the traction-suture the renal portion of the ureter has been implanted into the vesical portion. The ends of the traction-suture have been tied together.

6. The ureter is now enveloped carefully with peritoneum, as already described in other operations, provided an intraperitoneal operation has been done.

This method has many advantages, some of which are as follows:

1. The urine is made to pass through its normal channel. 2. Healing takes place at once, without even temporary loss of function or a temporary fistula. 3. No stenosis occurs even after a long interval of time. 4. The ureter can always be united, if accidentally injured at any operation, with materials always at hand. 5. Leakage cannot occur, because the upper extremity of the ureter acts as an obturator to the lower portion of the tube. 6. Scar-contraction can never injuriously diminish the lumen of the tube, because the scar which encircles the ureter after union by this method is equal in length to twice the extent of the incision in the side of the lower ureteral stump.

It is evident, upon reflection, that this method of reuniting the ureter after transverse division can be utilized for restoring the continuity of the duct, not only after accidental division, but also after division deliberately undertaken for the purpose of removing retro-ureteral morbid tissue in abdominal operations. It can be used also after removing a portion of the ureter by resection in continuity for strictures, and for ulcerations about calculi involving annular destruction of the mucous membrane, which would eventually terminate in stenosis if untreated.

This method has been successfully put in practice in the human subject by H. A. Kelly, Chrobak, and Bache Emmet. Paggi proposed end-in-end anastomosis. Hochenegg carried out transverse suture; oblique end-to-end suture is employed by Bovee.

Transverse wounds with loss of substance may also be closed by this method, even when the amount of tissue lost is 1 inch or more, since the ureter can be elongated considerably by gentle, steady traction.

When this cannot be accomplished, the writer has suggested the formation of a vesical diverticulum to receive the end of the ureter, if the ureter is injured near the lower extremity. The diverticulum may be made to reach a point within 3 inches of the umbilicus without opening the peritoneum. If the peritoneum is opened, the flap of vesical tissue can be so freely loosened that it may be made to reach within 1 inch of the level of the umbilicus.

Vaginal plastic operations are suggested when the ureter discharges directly or through a fistulous tract into it. The vagina may be utilized to make a new channel, or it may be closed (*kolpokleisis*) when the uterus is extirpated. When complete transverse injuries of the ureter occur in operations upon the female pelvic organs, the ureteral continuity should be at once restored if possible; but if this cannot be accomplished, the proximal end of the duct should be brought down under the interior vaginal mucous membrane as far as possible, to facilitate subsequent vesical implantation.

Implantation of the Ureter.—When the ureter is implanted into the bladder, it should be so passed through the bladder-wall as to take an oblique course similar to that which it normally takes. Implantation of the ureter into the intestines at any point is, in the writer's judgment, absolutely contra-indicated, because of the certainty of infection of the ureter and its kidney.

It is never logical to plant the ureter in the skin or in the vagina.

Fistulæ of the ureter may be treated by methods suggested by procedures already discussed, the details of which we lack space to

consider. It is most important to determine the condition of the entire ureter by careful use of the diagnostic resources already described. Nephrectomy is the operation of last resort, and is now indicated more and more rarely.

Strictures and valves are treated by longitudinal incision and suturing in the same direction (Fenger). Valves are sometimes excised.

Dilatations (hydro-ureter, pyo-ureter) are usually associated with similar conditions of the pelvis of the kidney. Removal of the obstruction, whether situated within the ureter or located in the bladder, prostate, or urethra, is indicated.

Stones in the ureter, usually due to the lodgement of small calculi
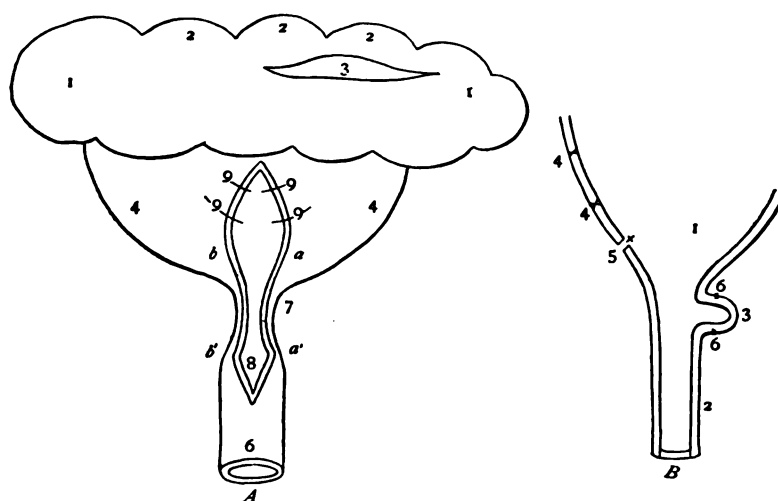
FIG. 316.—Illustrating operation for stricture of ureter. *A*, sacculated kidney, dilated pelvis, ureter with stricture at its upper end: 1, kidney; 2, sacs corresponding to dilated calyces; 3, nephrotomy; 4, dilated pelvis; 5, opening in posterior surface of pelvio-pelviotomy wound; 6, ureter below stricture; 7, stricture in upper end of ureter; 8, opening in ureter below stricture, extending up through the stricture into the pelvis; 9, sutures closing the upper half of the wound in the pelvis; *a*, *a′*, and *b*, *b′*, points of incison in ureter and pelvis to be united by sutures after folding the ureter upon itself at the place of stricture.

B, pelvis and ureter after union by sutures: 1, pelvis; 2, ureter; 3, fold of ureter at place of stricture; 4, sutures of wound in pelvis; 5, place of sutures between points *a*, *a′*, and *b*, *b′*; 6, 6, additional sutures, as many as needed to close borders of the fold formed by approximations of *a* to *a′* and *b* to *b′*.

coming down from the kidney, are not recognizable as such, except upon direct palpation extra-abdominally, by the vagina or through the bladder, or by catheterization or sounding the ureter either from below or from above. The writer once felt a stone in the ureter through the abdominal wall. Usually, symptoms of cystonephrosis or of vesical disturbance lead to careful examination of the ureters and the discovery of the calculus.

The stones may be removed by ureterotomy, either extra- or intraperitoneally, through the vagina or rectum, or through the dilated ureteral opening after incising the bladder.

Inflammations of the ureter are almost invariably ascending or descending, the infection beginning in the bladder or kidney rather

than in the ureter itself. Gonorrheal inflammation but rarely extends upward into the ureters, which are protected by the valve-action of the ureteral ostia. Pyogenic infections taking origin about calculi in the kidney or bladder, or in the cystitis of prostatics and infections from pyonephrosis, are usually transmitted to the ureter by direct extension.

These inflammations are recognized, as a rule, by their connection with the original malady. H. A. Kelly has treated ureteritis and pyelitis by catheterizing the ureters and renal pelvis with long, slender catheters, and washing out with mildly antiseptic solutions.

In the presence of ureteral calculi the ureter undergoes inflammatory changes, due to the pressure of the stone; and if infection takes place, ulceration and scar-formation ensue. The consequences for the kidney are serious when infection has occurred.

Tuberculosis of the ureter is usually secondary to either renal or vesical tuberculosis, and is, consequently, descending or ascending. In many of the recorded cases the disease produces nodular hard infiltrations, which give the ureter a cord-like feeling difficult to distinguish from similar infiltrations of other tubes of the neighborhood; for example, the vasa deferentia or seminal vesicles in the male.

The **diagnosis** is mostly made after evidence has established the existence of renal or vesical tuberculosis. Catheterization of the ureter has enabled H. A. Kelly to determine the coexistence of tuberculous ureteritis with nephritis.

Treatment.—In such cases extraperitoneal ureterectomy is to be performed, in order to free the patient entirely from the disease. Leaving the ureter after removal of the kidney is likely to result in the long-continued discharge of tuberculous pus from the lumbar wound.

CHAPTER XIX.

SURGERY OF THE KIDNEY.

Anatomy.—The kidneys are situated in the deepest part of the abdominal cavity, behind the peritoneum.

The twelfth rib divides the kidney into an upper and a lower half. The inner border of the kidney rests on the outer border of the psoas muscle; the remainder of the kidney lies on the lumbar fascia which covers the quadratus lumborum. The outer border of the kidney lies

FIG. 317.—*Mc*, trapezius; *Mld*, latissimus dorsi; *Sp*, sacrolumbalis; *Ql*, quadratus lumborum; *Oe*, obliquus externus; *Oi*, obliquus internus; *Tr*, transversalis; *Fld*, lumbodorsalis fascia; *R*, kidney; *C*, descending colon (from Esmarch and Kowalzig's *Surgical Technic*).

2 or 3 cm. ($\frac{3}{4}$ to $1\frac{1}{4}$ inches) external to the quadratus lumborum (Fig. 317).

Anomalies.—Absence of Kidney.—One kidney may be absent, the anomaly occurring in 1 out of 4000 cases (Morris). Rovsing believes this estimate too large. Beumer collected from the literature, between 1853 and 1870, 48 cases, in 44 of which the kidney was entirely absent, and in the remainder existed as a rudiment only. A number of fatal operations due to ignorance of this condition are on record.

Anomalies in Shape.—The union of the two kidneys, forming the "horseshoe"-shaped kidney or one of its varieties, is more easily detected before or during an operation, as the organ is located in the median line on the anterior surface of the vertebral column.

Anomalies in Position.—A kidney may be located in the small pelvis, and here, in case of pyonephrosis, may be difficult to remove or to operate upon.

Physiology.—The normal quantity of urine in adult males is 1000 to 1500 c.c. (2.1–3.2 pints); in adult females, 900 to 1200 c.c. (1.9–2.5 pints). It has a specific gravity of 1.015 to 1.025; and 30 to 40 grams (463–617 grains) of urea are excreted in the twenty-four hours.

If the quantity of urea is decreased to one-third of the normal, the individual is near the danger-point, and the slightest surgical operation will cause a further decrease, followed by fatal uremia.

Tuffier's experiments on dogs have demonstrated that the minimum amount of healthy kidney-tissue necessary for life is 1 to 1½ grams (15–23 grains) for each kilogram (2.2 pounds) of body-weight. An adult man should have 300 grams (9.6 ounces, Troy) of kidney-tissue; if his weight is 75 kilograms, or 150 pounds, he needs only 75 to 112 grams (2.4 to 3.6 ounces, Troy) of the 300 grams of kidney-tissue; that is, he can spare two-thirds or three-fourths of the normal amount of kidney-tissue before crossing the danger-line; and he may live in perfect or relative health for years, during the destruction of the kidneys, until the last fourth is reached and sudden uremia sets in.

When the amount of kidney-tissue approaches the lowest limit, the quantity of urea diminishes, although the amount of urine may still be normal. It is therefore a matter of vital necessity to examine the urine for urea before operating.

Compensatory hypertrophy or regeneration of kidney-tissue of a healthy kidney, when its fellow has been removed or destroyed by disease, has been studied experimentally by Tuffier. After extirpation of one kidney, he removed by successive partial operations portions of the remaining kidney, aggregating in all the weight of the kidney first removed. From this he concludes that as a quantity of kidney-tissue equal to both kidneys was removed without disturbing the health of the animal, at least the necessary one-fourth of the kidney-tissue must have been formed by regeneration or compensatory hypertrophy.

Examination and Diagnosis.—**Inspection** in the dorsal or knee-elbow position may reveal a swelling, which begins at the lateral border of the extensor dorsi communis and extends from under the border of the ribs obliquely downward toward the symphysis.

Palpation.—A normal kidney in normal position cannot be palpated; but if displaced or enlarged, it can be felt in the costo-iliac space by bimanual examination with the patient in either the dorsal position, the thorax elevated and the legs flexed, or in a half-sitting position, or else lying on the side opposite to the affected kidney. The enlarged kidney can be palpated between one hand in the lumbar region and the other hand on the abdomen, pushed gently up under the border of the ribs. In this position the kidney can usually be moved between the hands. Narcosis is often necessary for this manipulation.

The so-called **ballottement** (Guyon) is as follows: The one hand in the lumbar region makes sudden, short, quick pushes from behind forward, tossing the kidney against the hand on the abdomen.

Abdominal Percussion.—As the colon usually passes over the anterior surface of the kidney, an area of tympanitic percussion, when found, is a proof that the location of the tumor is retroperitoneal; although in some cases the colon may be pushed aside, and the tumor will show dull percussion over its entire surface.

Percussion of the lumbar region is uncertain.

Direct palpation of the kidney, when it is necessary to establish its presence, has been made through an abdominal incision (Knowsley Thornton). This procedure is attended with risk of peritonitis. Pal-

pation of the kidney through a lumbar (extraperitoneal) incision is not dangerous, and is a more satisfactory procedure.

Examination of Urine.—Examination of the collected urine must be made without delay, as the urine changes rapidly by decomposition. It should be noted whether the reaction is acid, alkaline, or neutral. Microscopical examination, after sedimentation by means of the centrifuge, may reveal red blood-corpuscles, white corpuscles, pus-cells, crystals, cylinders, and epithelial cells from the urinary tract, or, very rarely, abnormal cells from tumors. Chemical examination should be made for albumin, blood, and sugar. If the filtrated purulent urine contains
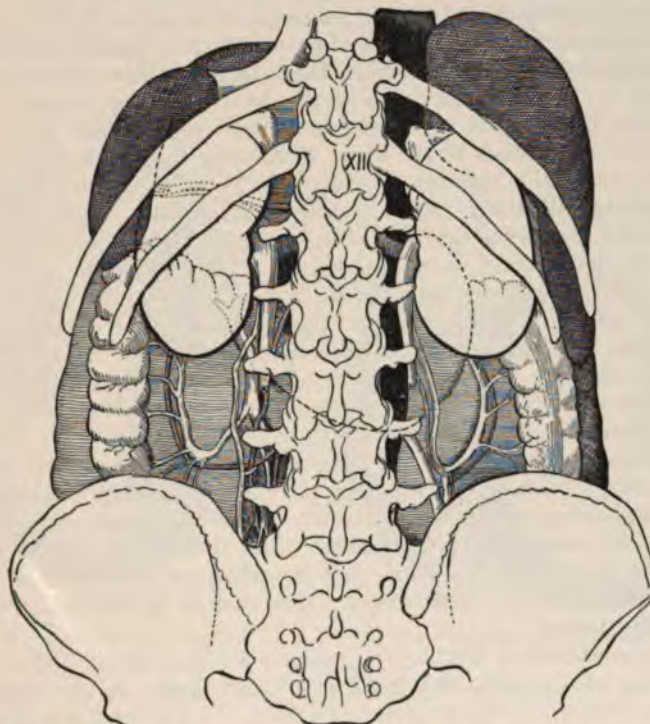
FIG. 318.—Relation of the kidneys as viewed through the lumbar wall. The two dark-shaded parts indicate the liver to the right, the spleen on the left; in front of the vertebral column the black tint represents the vena cava; the twelfth rib is longer than usual (after Farabeuf).

much albumin, disease of the kidney must be suspected, since the longer the pus-cells remain in the urine the more of them will be dissolved.

Quantitative Examination for Urea.—After the patient has been on a nitrogenous diet for some time, a sample from the twenty-four hours' urine should be examined, by Esbach's method, for example.

If the quantity of urea is below normal, as in cases of tumor, stone, and pyonephrosis, it may be concluded that the other kidney is not healthy, and consequently that operation is dangerous. As an aid in the differentiation between disease of the bladder and of the kidney, and in order to ascertain from which kidney the blood or pus is excreted, resort is

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made to cystoscopy. Direct cystoscopy through a tube, the light being thrown into the bladder, previously distended with air, from a head-mirror, as practised by Kelly, is useful in women. Indirect cystoscopy is made by means of Nitze's cystoscope, in which an electric lamp illuminates the wall of the bladder previously filled with water.

To collect the urine separately from each ureter, we resort to catheterization of the ureter by means of a long, fine, flexible, ureteral catheter, inserted by the aid of the cystoscope.

Direct examination of the kidney through an extraperitoneal (lumbar) incision is the last step in a positive diagnosis. When the surface of the kidney has been laid bare, we may palpate or aspirate, as in cystonephrosis and stone; or excise a piece of kidney-tissue for microscopical examination; or we may bisect the organ longitudinally down into the pelvis, as in case of stones in the calyces, stenosis, valve-formation, or abscess. Division of the healthy kidney-tissue, even in the median line, causes considerable hemorrhage, which may be controlled by compression of the renal vessels by the hand of an assistant or by an intestinal compressor, or directly by packing with gauze.

Floating Kidney (*Ren Mobilis*).—When the fixation-apparatus of the kidney becomes defective the organ becomes movable and sinks downward and forward in the abdomen. This condition was found in 0.2 per cent. of autopsies by Ebstein, and in 2.2 per cent. of the patients by Skorckewsky. It is more common in women than in men : Lancereaux gives the proportion as 55 women to 5 men. It is found four times as often on the right side as on the left, probably because the heavy liver pushes the right kidney out of place. Movable kidney is usually found in patients from twenty to forty years of age. It is said to be caused by atrophy of the adipose capsule, by repeated pregnancies, by enteroptosis, when the displaced intestine makes traction on the kidney, and by pressure on the waist, due to the corset or skirt-string. It is seldom caused by traumatism. The downward displacement of the kidney may result in circulatory disturbances, by reason of traction on the vessels, and in retention of urine, due to bending of the upper end of the ureter.

The **symptoms** of floating kidney are a falling or sinking sensation, or a feeling of heaviness in the side, and pain, either steady or paroxysmal, from torsion of the vessels or ureter. A fact of great diagnostic importance is the disappearance of the pain when the patient lies down and the kidney returns to its proper place. Digestive disturbances consequent upon the enteroptosis, neurasthenia, varices, and hemorrhoids are found in many cases.

The **diagnosis** is made by bimanual palpation, when a smooth, movable tumor, shaped like the kidney, is felt and can be easily pushed up in place. The tumor is in some cases painless ; in other cases tender on pressure. It is of the size of the kidney, unless bending of the ureter has caused retention and dilatation of the pelvis and calyces. The tumor may increase to double the size of the kidney during an attack of pain ; that is, retention, or during menstruation.

The **prognosis** is good as to life, but spontaneous cure is not to be expected.

Treatment.—An elastic abdominal supporter, with a pad under the

ribs, together with appropriate internal treatment, should always be tried first, as many patients obtain a sufficient degree of relief therefrom. If this treatment fails, the operation of nephrorrhaphy or nephropexy, which was first made by E. Hahn, in 1887, should be performed. The operation is as follows: After lumbar incision and division of the capsule, the kidney is laid bare, pushed up into its normal location, and the fibrous capsule, together with a layer of the cortical substance, united with the fascia and outer periosteum of the twelfth rib by three or more silk sutures. To avoid relapse, however, it is advisable to follow the suggestion of Tuffier, who, in addition to the sutures, dissects out a flap of the fibrous capsule 2 cm. broad and of the length of the kidney, and unites this flap with the borders of the divided muscles. Nephrorrhaphy has a mortality of about 1 per cent. to 1.8 per cent.; about 65 per cent. of permanent cures; in 10 per cent. of the

FIG. 319.—Tuffier's operation. FIG. 320.—Result of Tuffier's operation
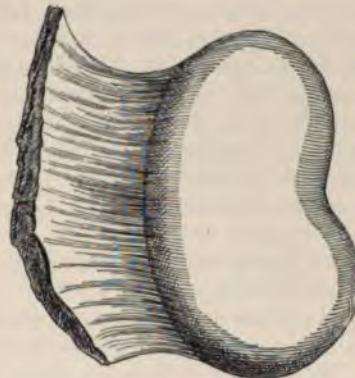
cases improvement takes place, and relapses occur in 22 per cent. of the cases.

Trauma of the Kidney.—**Contusion.**—Traumatic subcutaneous rupture of the kidney is caused by direct violence, either from a small body through the iliocostal space, as, for instance, a wagon-wheel, the kick of a horse, a fall against a rail or the edge of a table, etc.; or by a large body striking the abdomen with such force as to break the ribs or pelvic bones before reaching the well-protected kidney. The kidney is thus squeezed between the object and the twelfth rib or the transverse process of the first lumbar vertebra. The extent of the rupture may vary from a small, subcapsular tear to complete bursting of the organ. The rupture is ordinarily stellate and transverse, and extends through the capsule into the pelvis. The resultant hemorrhage may be limited to the kidney-tissue and capsule, or the blood may flow down the ureter or may enter the abdominal cavity through a tear in the peritoneum. In case of a small rupture the blood is absorbed in a few weeks, leaving

a cicatrix which shuts off the divided urinary tubules. This causes atrophy of the cortical portion of the obstructed canal; consequently, the greater the number of the canals divided, the greater the loss of cortical substance. A completely ruptured kidney will shrink until it becomes a useless lump of connective tissue.

Symptoms.—Shock is common; but if persistent, is probably due to intraperitoneal hemorrhage or to injury to other abdominal organs. The pain in the kidney extends down along the ureter. Sometimes renal colic, due to coagula in the ureter, and attended by vomiting, is present. Hematuria is almost a constant symptom, being absent in only 8 per cent. of the cases, as when the rupture is cortical or when the ureter is crushed or obliterated. The hemorrhage usually ceases in from two to five days; it is rarely persistent or remittent, or so considerable as to cause anemia. Anuria, which is a grave complication, or oliguria, is common during the first forty-eight hours, and is then followed by polyuria. The tumor is small if the rupture is intrarenal; when peri-renal, it is larger and more diffuse, and is due to an accumulation of blood and urine outside of the kidney. In aseptic cases there is a slight rise in temperature from 100° to 102° F. This gradually decreases after a few days. If infection takes place, as often occurs from an infected catheter, or, more rarely, from pre-existing cystitis or microbes in the circulation, chill and increasing temperature up to 104° F., with pain and pyuria, may supervene. This is a grave complication, and has a mortality of 47 per cent.

Prognosis.—If the rupture is limited to one kidney, the mortality is 22 per cent. (Rovsing); when complicated with fractures or injuries of other organs, the mortality is increased to 87 per cent. Primary hemorrhage caused death in 6 and secondary hemorrhage in 4 of 71 cases (Maas). Three-fourths of all cases heal spontaneously, without operation and without complications.

Treatment.—Absolute rest in bed for three weeks is essential to avoid the danger of secondary hemorrhage. Stimulants should be given during the period of shock, and morphin for the pain. Local application of cold (ice-bag) is often employed; and Tuffier recommends compression of the costo-iliac space by a pad of cotton held in place by a flannel bandage. The patient should be put on light liquid diet. Ergot, acetate of lead, or other hemostatics may be employed. It is important to avoid the use of the catheter; or if the catheter must be used, it is absolutely essential to secure asepsis. Hemorrhage or infection may necessitate operative treatment. Hemorrhage from the larger vessels may be stopped by ligature or tampon; but if the whole kidney is found to be crushed, it should be removed. Infection may require evacuation of pus by nephrotomy, followed by drainage; or nephrectomy, if the greater part of the kidney-tissue is destroyed or if the kidney is the seat of multiple abscesses.

Wounds of the Kidney.—Wounds of the kidney are rarely observed in time of peace. Punctured wounds by the stiletto or rapier are rare, and heal readily. Incised wounds by the saber or knife are also rare, but gunshot wounds are more common. Hemorrhage is considerable only in incised wounds or when large vessels are divided; in punctured and gunshot wounds the hemorrhage is usually slight. An aseptic

incised wound will heal in about seven days. Infection and extravasation of urine do not occur unless the pelvis has been opened. The blood-clot which fills the wound is absorbed in from two to seven days, and is replaced by granulation-tissue. The amount of kidney-tissue lost by atrophy depends upon the number of tubules divided. Thus, a longitudinal wound on the anterior or posterior surface of the kidney causes more atrophy than either a longitudinal wound along the convex border, which is attended by slight hemorrhage, or a transverse wound, which is followed by a greater hemorrhage. An incision parallel to the course of the uriniferous tubules divides the smallest possible number. Gunshot wounds heal readily, and an aseptic bullet may become encapsulated and cause no disturbance. Infection leading to local or diffuse suppuration disturbs the process of healing, and the danger of sepsis makes the course protracted and serious.

Symptoms.—Shock is observed, especially in gunshot wounds. The external wound may be in the lumbar region over the kidney or at a distance from it. The hemorrhage may be internal if large vessels are divided, or external and abundant; but is usually not fatal in incised wounds. Secondary hemorrhage is due to infection only. Urine exudes from the wound only when the pelvis has been opened, and when its passage through the wound is more easy than through the ureter. It was seen in 23 per cent. of gunshot wounds, and in only 3 per cent. of incised wounds. Pain may be absent from the outset; if it appears on the second or third day, it usually signifies peritonitis; if on the eighth to the tenth day, it means infection of a cavity containing blood and urine. Hematuria is a pathognomonic symptom, but is absent in 42 per cent. of the cases; it is common in gunshot wounds because the pelvis has been opened.

Complication with injuries to other organs, as, for instance, the lungs, liver, spleen, or intestines, must be carefully considered. The kidney may be found prolapsed into or outside of an incised wound; if viable, it should be disinfected and replaced. Infection of the extravasated blood and urine through the wound or from catheterization will cause pain, fever, and increase of the lumbar swelling, and calls for prompt evacuation and drainage. Peritonitis is common in gunshot wounds, and may also be caused by infection.

The *prognosis* is doubtful. A mortality of 60 per cent. for all cases is reduced to 31.5 per cent. in the uncomplicated wounds (Rovsing). Gunshot wounds are more grave, having a mortality of 42 per cent.; while incised and punctured wounds are attended by a mortality of only 26 per cent.

Treatment.—Gunshot wounds should be sealed after thoroughly cleansing the skin, and the patient should be kept in bed for at least three weeks. If a large swelling and symptoms of anemia appear, the kidney should be laid bare, and the hemorrhage stopped by ligature or tampon; or nephrectomy should be made if the renal vessels are injured. Incised wounds with external hemorrhage should be freely opened and the kidney examined. If the wound is aseptic, the kidney can be sutured; if infected, the hemorrhage should be stopped by packing, and the wound united later on by secondary suture. If urine exudes, drainage is required. If infection of the accumulated blood and urine

occurs, as indicated by onset of fever, pain, and increased lumbar swelling after eight or ten days, free incision (nephrotomy) or, eventually, nephrectomy must be made. The hematuria almost always stops spontaneously; but if it persists despite rest and ergot, and if copious, the patient's life may be saved by nephrectomy (in 5 out of 6 cases, Tuffier). If the bladder is filled with coagula, causing vesical retention, catheterization is usually resorted to; but this is difficult, as the clots usually occlude the eye of the catheter. It is better, therefore, to use Bigelow's litholapaxy evacuator. If this procedure is unsuccessful, suprapubic puncture and aspiration of the urine and liquid blood may be of assistance for the few days required for the crumbling of the coagula. If aspiration is tried in vain, the bladder must be opened, either by perineal section or, preferably, perhaps, by epicystotomy.

Renal Calculus (*Nephrolithiasis*).—Stones are found in the parenchyma, the calyces, and the pelvis of the kidney. The small concretions, sand or gravel, which easily pass out with the urine belong to the field of internal medicine; and it is not until the concretions become so large that they cannot pass out from the calyces or pelvis that the aid of surgery is invoked.

In 50 per cent. of the cases only a single stone is found, and in the remaining half ordinarily 2 to 10, and occasionally many (200) small stones are found. The size varies in uric-acid and oxalate-of-lime stones from that of a hazelnut to that of a walnut; the phosphatic stones are much larger. The weight varies from 10 to 1000 grains. The shape of renal stones depends, as does the shape of vesical calculi, first on the form of the crystal. Thus, a uric-acid stone is oval, and an oxalate-of-lime stone spherical. The shape depends, in the second place, upon the shape of the cavity in which it is located. Thus, in the ureter we find cylindrical stones; in the ureteral portion of the pelvis, where the ureter divides into two branches, a Y- or heart-shaped stone; in a calyx, an hour-glass-shaped stone, part of which is in the calyx and part in the pelvis; and, finally, when a stone fills both pelvis and calyces, it will be coral-shaped, having a stem corresponding to the pelvis and branches corresponding to the calyces. The physical characteristics of stones vary with their composition. Thus, uric-acid and urate stones are yellow or reddish, hard, smooth, or finely granulated; oxalate-of-lime stones are chocolate-colored, hard, rough, and nodular, the color depending upon a covering of blood-pigment; the phosphatic stones are gray or white, soft and friable. We often find a nucleus of one substance surrounded by concentric layers of other substances.

Stones in the kidney are found at all ages, and with equal frequency in both sexes. There is no difference as to frequency between the right and the left kidney. Fortunately, the disease is limited to one kidney in most cases. Dickinson found bilateral lithiasis in only 11 out of 59 cases.

The **cause** of stone-formation is not well understood. Urate stones seem to be hereditary and coexistent with uric arthritis throughout several generations. There are three theories as to their formation. The old theory is that an anomaly in metabolism causes the urine to deposit the elements of the stone around dead cells from a catarrhal inflammation of the mucosa (Ebstein). Galippe considers that they may be caused by microbes in the urine. Stones may also be formed around small blood-clots or other foreign bodies as nuclei. If the urine is acid, we find uric and oxalate calculi; if it is alkaline, phosphate and carbonate-of-lime stones are formed.

Pathological Anatomy of the Calculous Kidney.—A stone may exist in the kidney for as many as thirty years and do no harm to the secreting tissue, provided it does not cause obstruction or infection. A stone in the pelvis at the ureteral orifice is liable to cause a variable degree of obstruction, retention of urine, and dilatation of the pelvis and calyces, with gradual atrophy of the kidney-substance from interstitial nephritis. Infection may occur by invasion of microbes, either from the bladder or, more commonly, from the circulation. The stone wounds the mucosa, micro-organisms from the blood or kidney-urine find a favorable culture-medium, and an inflammation of the pelvis—a pyelitis—results, which extends to the kidney-tissue and causes its destruction. If retention and infection are combined, the kidney is more rapidly annihilated, abscesses form in its substance and extend to the perirenal tissue, resulting in perinephritic abscess. A dilated pelvis may contain a large stone, with smaller stones in the dilated calyces; these form thin-walled globular promi-

nences on the surface of the kidney, which is usually enlarged, and is thus transformed into a multilocular sac filled with purulent urine around the stones—the condition called by Küster *sacculated kidney* (Fig. 321).

Symptoms.—The main symptoms of nephrolithiasis are pain, attacks of renal colic, and hematuria. It is remarkable that even large or multiple stones may give rise to no symptoms at all. In autopsies in St. Bartholomew's Hospital, Bruce Clark found 24 cases of nephrolithiasis, in all of which no symptoms had existed. In other cases there may be only slight lumbar pain or occasional attacks of renal

FIG. 321.—Multiple calculi in a sacculated kidney (Rovsing). Very large stone in pelvis; the whole kidney transformed into a number of cystic cavities filled with pus; each of the dilated calyces contains a large stone; fibrous degeneration of kidney-tissue (⅔ natural size) nephrectomy; recovery.

colic during the patient's life. In a few cases sudden calculous anuria is the first manifestation. In the majority of non-infected cases, however, the following symptoms are marked:

1. *Pain in the Region of the Kidney.*—The pain may vary from a simple soreness to a tearing, biting pain. It is seldom continuous; often remittent. The attacks are brought on by exercise, or sometimes by palpation. It may cause lateral lumbar scoliosis, from habitual bending of the back. It may radiate down into the inguinal region, or toward the abdomen, and by reflex action cause respectively vomiting and fre-

quent painful micturition; or it may extend down the anterior side of the thigh and simulate crural neuralgia. The pain usually disappears at night or when the patient lies down.

2. *Hematuria* is almost constantly found, but the amount of blood is usually so slight as to be detected only by microscopical examination of the sediment after the urine has been centrifuged. It is increased by exercise and pressure.

3. *Physical Symptoms.*—The kidney cannot be made out by palpation unless it is dilated or displaced, in which case grating from multiple stones may in rare instances be observed.

4. *Renal Colic.*—The attacks of pain extending from the kidney down along the ureter are probably always due to painful contractions of the ureter, and would better be termed ureteral colic (Rovsing). This is caused in most instances by passage of a stone; rarely, of coagula or echinococcus-cysts down the ureter.

The acute onset, the violence of the pain, tympanites, constipation, frequent micturition, perspiration, and relief upon pressure on the abdomen or flexion of the thighs, characterize the attack, which may last from four to six hours to as many days, and ceases suddenly when the stone enters the bladder, or diminishes gradually, leaving a tender spot in the course of the ureter, if the stone is here arrested.

Diagnosis.—In tumors the hematuria is more abundant. In tuberculosis we must inoculate a guinea-pig if the bacillus cannot be found. It may be impossible to distinguish between stone and nephralgia or to determine whether or not an infected cystonephrosis contains stone. In the latter case an exploratory lumbar incision is indicated, as it is not dangerous and is ordinarily the first step in a curative operation.

Complications.—Infection causing pyelonephritis is especially common, and is the beginning of loss of health and strength. The microbes most commonly enter through the circulation, where the colon-bacillus frequently exists; or more rarely we may have an ascending infection from below, due to the use of an unclean catheter. The colon-bacillus is often tolerated for years without marked discomfort; while the pyogenous staphylococci and streptococci cause serious illness, with acute fever, rigors, pain, and all the dangers incident to sepsis.

Calculous Anuria.—Suppression of urine occurs when a stone suddenly obstructs the passage of urine from the only kidney in function. It occurs in bilateral lithiasis, in advanced disease, or, more rarely, when the other kidney is absent. The onset is sudden, occurring without symptoms or during an attack of renal colic. Tuffier gives the course as follows: In cases of complete anuria there is a period of tolerance, when the patient feels quite well for five to eight days; this period is much longer if some urine is passed. This is followed by a period of intoxication, during which the patient becomes weak, has a dry tongue, hiccough, tympanites, subnormal temperature, contracted pupils, and edema around the malleoli. In 71 per cent. of the cases death occurs during the first three weeks; and in 28 per cent. spontaneous recovery takes place by re-establishment of the passage of urine. Many lives have been saved by timely nephrotomy.

Prognosis.—The prognosis is desperate only in calculous anuria. It is serious in the septic cases, although the patient may live for years;

and good in the non-infected cases, especially in those without dilatation.

Medical Treatment.—Medical treatment should always be resorted to after operation for removal of stone, and in some cases in which operation is deemed unnecessary or dangerous. In acid lithiasis with urate or oxalate stones, lithia-water, from a pint to a quart a day, and half a teaspoonful of sodium bicarbonate with the meals, should be given for six weeks, to be repeated three or four times a year. The alkaline mineral waters, open-air exercise, regulated diet, and sparing use of alcoholics will serve as an outline of the treatment. In alkaline or phosphatic lithiasis the urine should be made acid by the use of boric acid in doses of 50 cgm. (7.7 grains) or salol in $\frac{1}{3}$-gram (5.1 grains) doses three or four times a day. Three or four pints of cold boiled water should be taken daily by all patients.

Surgical Treatment.—The operations for nephrolithiasis are nephrolithotomy, pyelolithotomy, nephrotomy, and nephrectomy.

Nephrolithotomy.—Through an oblique lumbar incision the kidney is isolated, brought out into the wound, and palpated in order to feel stones in the pelvis. The stones in the calyces are sought for by puncture with an aspirator-needle, and if found are removed by an incision made with the needle as a guide. If retention exists the pelvis is found by aspiration, and the kidney opened on its convex surface on the needle as a guide. When the pelvis is opened, exploration is made with the finger or metal sound. The stones are extracted after division if they are very large, but always with as little manipulation as possible. The hemorrhage from healthy kidney-tissue is considerable, and must be controlled by compression of the vessels in the hilus or by local pressure with gauze sponges. The thermocautery may also be of use as a hemostatic.

The ureter is then examined with a metal probe to determine its permeability and to detect stone. The stones extracted should be carefully examined to determine whether pieces have been broken off and left in the kidney. If asepsis is certain, the wound in the kidney should be united by catgut sutures, by which hemostasis is assured. Primary union may take place.

Pyelolithotomy.—If the stone is located in the pelvis near the ureter, it may be removed through an incision in the posterior pelvic wall. This operation possesses the advantage that no hemorrhage is produced; but it has the disadvantage that stones are more easily overlooked; and the operation is said to be more frequently followed by fistula (Rovsing).

Nephrotomy is the operation of opening into a suppurating kidney to evacuate pus and remove stones, if present. The kidney is opened at its most prominent point over one of the thin-walled sacs. Exploration is then made with the finger and steel sound for stone. This must be done carefully, as stones are either not found or all the stones may not be removed, as was the case in 16 per cent. of 114 cases reported by Tuffier. The thin, atrophic kidney-wall does not bleed. The wound in the kidney is united to the skin and the cavity packed and drained, in order to overcome the pyelitis by local treatment.

Nephrectomy, which was formerly much in vogue, has been almost entirely abandoned. It possesses the advantage that if the patient survives he is cured by a single operation; but the mortality is 38 per cent., as against 33 per cent. mortality for nephrotomy. For this reason many operators follow the advice of Guyon, first to make nephrotomy, and later on, nephrectomy, if demanded. This secondary nephrectomy, after the lapse of months or years, is a relatively safe operation.

Treatment of Calculous Anuria.—When the only useful kidney is closed by stone, nephrotomy, as suggested by Thelen in 1882, should be done during the period of tolerance. Hot baths, careful massage of the ureter, electricity, and chloroform-narcosis may be tried for a day or two. If the patient is not operated upon, Tuffier and Legueu's statistics show that 28 per cent. recover by spontaneous expulsion, and that 72 per cent. die; while operation has saved 60 per cent.

Technic of Operations for Stone in the Kidney or Pelvis.—The patient is anesthetized with ether and placed on the well side, with a pillow under the costo-iliac space. An oblique incision is made, parallel to the twelfth rib, from the erector spinæ forward and downward through the skin, latissimus dorsi, the three flat abdominal muscles, the transversalis fascia, and the lateral portion of the quadratus lumborum muscle. The adipose capsule can then be seen to move with the respiration, and is divided. The surface of the kidney is denuded and the organ isolated by blunt dissection, first on the posterior and then on the anterior surface, until the vessels and pelvis are reached. The kidney and pelvis are now palpated to detect the presence of dilated calyces, abscesses, or stone. If a stone is felt in the pelvis and grating noticed when an aspirator-needle is inserted, the stone may be removed.

Pelviotomy.—This consists in a longitudinal incision on the posterior surface of the pelvis. No hemorrhage follows this incision; while division of healthy kidney-tissue is attended by a considerable loss of blood. When the stone is removed, exploration with the finger or steel urethral sound should be made to detect the presence of stones in the calyces. A flexible sound is inserted in the ureter to determine its patency. If there is no infection, the wound in the pelvis can be united, and the external wound closed around a gauze drain. If no stone is felt in the pelvis, we next resort to

Nephrolithotomy.—Thorough exploration should be made with a thin aspirator-needle inserted in different parts of the middle longitudinal line of the kidney. If a stone is felt, the needle should be left in place and the stone cut down upon, the needle being used as a guide. If no stone is detected, the pelvis should be opened from the convex surface of the kidney. It is difficult to find the pelvis in a normal kidney; but if there is a little dilatation, the pelvis may be made out by aspiration of urine or pus, the needle being left in as a guide for the knife. After the pelvis has been opened, the stones are sought for by the finger or steel sound, the narrow entrances to the dilated calyces enlarged, and all concretions removed. In aseptic cases many operators close the incision in the kidney with sutures; this method possesses the advantage of stopping the hemorrhage. If infection exists, the kidney must be drained, and hemorrhage stopped by packing. Some authors (Morris and Tuffier) make a distinction between nephrolithotomy as an operation for the

removal of stone from a healthy aseptic kidney, and nephrotomy for the operation for the removal of stone from a suppurating kidney.

Nephrotomy, or incision into a suppurating calculous kidney (Sachniere), is an easier operation, as the atrophic kidney-tissue does not bleed and as the pelvis can easily be found. It is well to unite the wound in the kidney to the skin, in order to avoid perirenal infection. The kidney should then be packed and drained.

Nephrectomy is done in rare cases of acute or chronic infection either because the kidney is valueless or is a dangerous source of infection by reason of multiple abscesses in the kidney-substance. Only the second of these indications is vital in order to save the patient during acute sepsis, which is a very rare contingency. Many authors advocate nephrotomy as the normal procedure, because it is impossible to know the exact secretory value of the organ or whether the patient can survive its loss. It is better to leave the kidney, and if, later on, it is found to be valueless, to resort to secondary nephrectomy.

Suppurative Infective Inflammation of Kidney and Pelvis (*Pyonephrosis and Pyelonephritis*).—Infection of the upper urinary tract centers in the pelvis (pyelitis), but almost always extends above to the kidney (nephritis) and below to the ureter (ureteritis). The microbes which cause the infection require certain favorable conditions for their localization. Chief among these are decreased resistance of tissue-elements and impeded evacuation of the urine, in which the microbes find a culture-medium, or a combination of both these conditions. The microbes enter either through the circulation or by ascent of the urinary passages from without.

Etiology.—Impediment to evacuation of the urine may be caused by any obstruction from the external orifice of the urethra to the calyces, such as stricture of the urethra, hypertrophy of the prostate, disease of the ureter causing stenosis, stone, or stricture, pressure from the gravid uterus or tumors, obstructions in the renal pelvis from stone or valve-formation, and obstruction in the calyces. Decreased power of resistance of tissue-elements may be due to arterial sclerosis or to paralysis consequent upon fracture of the spine. A combination of the factors named above is well illustrated by the pyelonephritis so commonly observed in connection with hypertrophy of the prostate.

The microbes enter from the circulation. Pyemia may cause a metastatic abscess in the kidney-tissue, as in osteomyelitis; but more commonly a traumatism to the organ, as caused by rupture or stone, gives a favorable soil for the localization of microbes circulating in the blood. This statement has been corroborated by the experiments of Albarran.

The microbes invade from below. An unclean catheter may infect the bladder and cause cystitis. This is often unavoidable in hypertrophy of the prostate. The microbes ascend through the ureter, either in the urine or in the mucosa. Gonorrhea rarely causes pyelitis (in about 3 per cent. of the cases only), and then it is probably due not to the gonococcus alone, but to mixed infection with pus-microbes.

Chemical substances, such as turpentine, cantharides, etc., will cause an aseptic and, consequently, transitory inflammation.

The microbes most commonly found are the Staphylococcus aureus, the colon-bacillus, and the Streptococcus pyogenes; occasionally the pneumococcus and typhoid bacillus have been observed.

Pathological Anatomy (*Pyelitis, Nephritis*).—The kidney and its pelvis are surrounded by a dense mass of fibrous and adipose tissue, because the microbes or their ptomains invade the adipose capsule and cause a chronic inflammation resulting in adhesions to all the surrounding organs—fasciæ, muscles, vena cava, and colon—making ordinary nephrectomy difficult. In such cases subcapsular nephrectomy (Ollier), shelling out the kidney and

leaving the capsule, can be accomplished with little loss of blood.   In pyelitis without dila-
tation we find in acute cases that the mucosa is swollen, red, ecchymosed, and covered with
fibrinous deposits or sandy incrustations ; in chronic cases the wall is thickened and ulcers
(flat defects) are seen in the grayish-red mucosa, covered with grayish-red detritus and gravel.
In pyelitis with distention the pelvis and almost always the calyces are dilated, so as to form
a multilocular sac on which the thin wall of the kidney sits like a cap, the surface of which
is nodulated from the globular, prominent dilated calyces (Fig. 322).
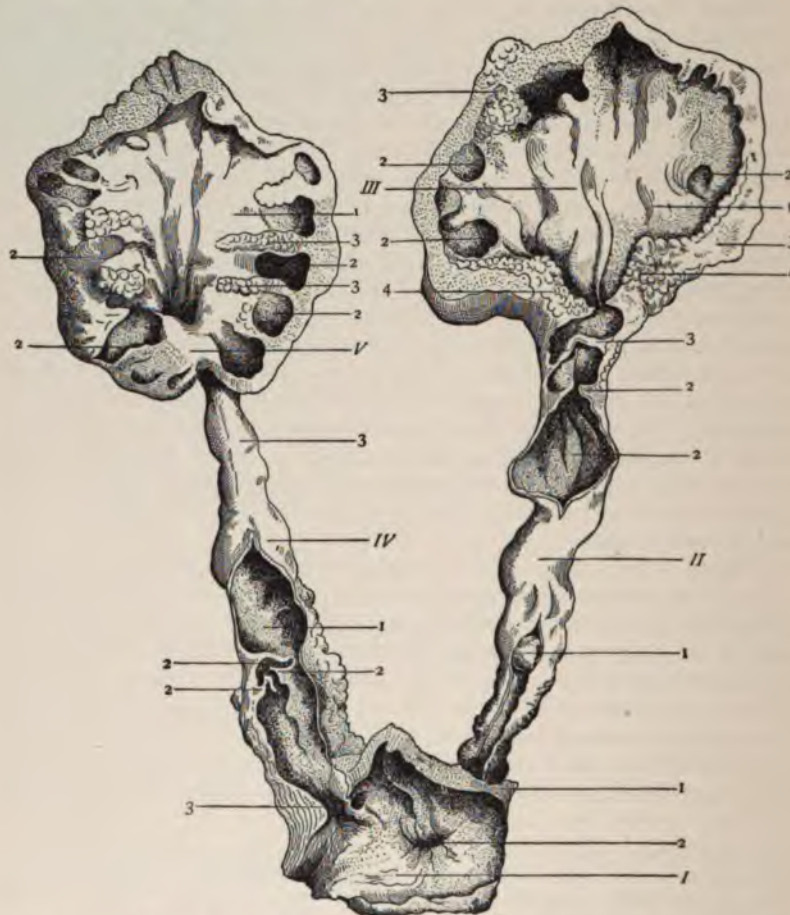
FIG. 322.—Double ureteropyelonephritis, with stricture and dilatation of the ureter (Musée
Guyon, specimens Nos. 158 and 159).   *I.* Part of the opened bladder : 1, hypertrophic vesical
wall ; 2, vesical opening of left dilated ureter ; 3, vesical opening of right ureter.   *II.* Left
ureter opened and unfolded in its upper portion ; split in its lower portion : 1, stone arrested in
lower third of canal ; 2, lumen of dilated ureter constricted by two valvular folds, 3, 3.   *III.*
Left kidney opened on its convex border : 1, cavity of dilated pelvis ; 2, openings to dilated
calyces ; 3, renal tissue ; 4, fibrolipomatous deposits.   *IV.* Right ureter opened in its lower
half : 1, cavity of the canal ; 2, imbricated valvular folds ; 3, narrowed upper portion.   *V.*
Right kidney opened on its convex border : 1, cavity of pelvis ; 2, calyces ; 3, fibrolipomatous
septa.

The kidney-tissue is sclerotic from interstitial nephritis.   It may contain miliary abscesses,
appearing as whitish points or stripes ; or, as is seen in many cases of hypertrophy of the
prostate, the large hyperemic kidney may appear normal, but microscopical examination
reveals a diffused microbic interstitial nephritis.

Symptoms.—*General Symptoms.*—Acute cases are marked by rigor, fever (102° to 105.5° F.), vomiting, delirium, coma, and death; or by continued fever and emaciation if life lasts for many weeks. In chronic cases there is either no fever or the fever is slight (100° F.); but there are dyspepsia, loss of appetite, the tongue is coated or clean, aphthæ in the pharynx, flatulence, tympanites, diarrhea, mental depression and weakness, pulse soft and irregular, and finally subdelirium and death ensue. This condition may last in light cases for months or years, and constitutes the so-called *urinary cachexia.*

Local Symptoms.—If the kidney is not distended, no tumor can be felt. In cases of old men with chronic cystitis, polyuria is observed early. The patient passes from 2 to 4 quarts daily, containing a little albumin and a few cylinders besides the pus-corpuscles. The acid or neutral urine becomes alkaline. If the quantity of urine decreases to 500 or 600 c.c. (16 to 20 ounces) there is danger of uremia. The hematuria is ordinarily slight, but is sometimes abundant. The kidney may be tender on deep pressure, but spontaneous pain is uncommon. Frequent micturition indicates cystitis. If retention is present, the distended kidney may be felt as a round, firm tumor, which may evacuate its purulent contents into the bladder from time to time, the evacuation being followed by temporary relief of the pain and fever. The urine, which was clear during the attack, will then be found purulent.

The **prognosis** is always serious, the more so if retention and infection are combined, or the disease is bilateral. If only one kidney is affected, spontaneous cure or cure by operation makes the prognosis more favorable.

Diagnosis.—The differential diagnosis from cystitis, tuberculosis, and tumors must be made. Further, whether one or both kidneys are diseased; if only one, it must be determined which is the affected kidney. In 61 deaths following operation for pyelitis the opposite kidney was found to be diseased in 56 per cent. (Tuffier). Cystoscopy and collection of the urine separately from each ureter, either by Harris's instrument or the ureteral catheter, may be required.

Treatment.—We must treat or cure the cystitis and overcome the causes of retention (stricture, enlarged prostate, abdominal tumors, etc.).

Primary pyelonephritis in a patient who has free passage of urine is amenable to internal treatment. The lines upon which the treatment is based are rest in bed, increased diuresis by drinking large quantities of water or milk, and sodium biborate up to 30 grams (7 or 8 drams) a day (Terrier). Salol, in doses as large as 3 grams (46 grains), three times a day, has been recommended, but is apt to cause poisoning (hemoglobinuria). Boric acid and the alkaline waters are safe agents to employ.

When the disease is unilateral or the sepsis acute, operative treatment is indicated. Nephrotomy is the operation of choice. The steps of the operation are lumbar incision, evacuation of the perinephritic abscess, incision of the kidney, evacuation of pus and stones, division of partition-walls in multilocular cavity, irrigation, packing with sterile gauze, and drainage after suturing the kidney wound to the skin.

If the suppuration persists, secondary nephrectomy may be required. If a fistula remains and the kidney is worth saving, a secondary opera-

tion to re-establish the passage through the ureter is required. Primary nephrectomy should be made only when the kidney-tissue is filled with multiple abscesses, and the organ must be removed to save a life imperilled by acute sepsis. Nephrectomy should also be made in all cases where no active kidney-tissue remains. It is, however, usually impossible during an operation to determine the secretory value of a kidney; nephrotomy should, therefore, always be first attempted.

In operations for nephritis, as in all operations on the kidney, it is not permissible to employ poisonous antiseptics. Sterile water should be used and sterile gauze—not iodoform gauze, as has been so often recommended.

Tuberculosis of the Kidney.—**Etiology.**—Renal tuberculosis is rare, being found in only 2 per cent. of tuberculous patients (Heiberg, Morris). The tubercle-bacillus ordinarily reaches the kidney through the circulation; but it may ascend through the ureter from below, from the seminal vesicles, prostate, or bladder. The bacillus may have disappeared from the original place of invasion, or a primary focus (hilus gland of lung) may be at rest. The kidney is then relatively the only tuberculous organ of the body (primary renal tuberculosis). If in tuberculosis of the urinary organs the kidney is first attacked, we speak of this condition, which is found in the majority of cases (Heiberg), as primary renal tuberculosis. The disease is usually unilateral—in 216 out of 350 cases (Rovsing). This fact is important, as it makes surgical aid possible early in the disease. It is more common in the right than in the left kidney. In the course of time the other kidney may be attacked. This ordinarily occurs through the circulation, seldom by continuous extension from the bladder. The disease is met with twice as often in men as in women, because the genital tuberculosis so common in man, due to disease of the testis, prostate, etc., has a peculiar tendency to reach the kidney through the circulation. More women (70 per cent., Facklam) are operated upon, however, because advanced genital tuberculosis in man prevents operation on the kidney in many cases.

Pathological Anatomy.—Diffuse miliary tuberculosis of both kidneys, like the same condition in other organs of the body, does not belong to surgery. The localized (hematogenous) tuberculosis begins in the cortical substance or in a calyx or papilla (Heiberg). The tuberculous nodule grows, liquefies in the center, and finally opens into the pelvis, which event is indicated by the presence of pus and blood in the urine; or it may open through the capsule, in which case it forms a tuberculous perinephritic abscess in the fibrolipomatous pararenal tissue.

In the pelvis the tuberculosis extends by contiguity, transforming the mucosa, papillæ, and pyramids into a thick, grayish-white mass of coagulation-necrosis tissue surrounded by a brim of living grayish tuberculous granulation-tissue, and covered with tuberculous pus and urine. The wall of the pelvis thus becomes rigid and thickened, and the same condition or process extends down into the ureter. If the latter becomes occluded by débris, or stenosed from swelling of its wall, retention of urine and dilatation of the pelvis and calyces ensue, causing enlargement, so that a tumor may be discovered by palpation (tuberculous cystonephrosis). Chronic renal tuberculosis is most frequently encountered in middle age.

Symptoms.—The pain is dull, continuous in the region of the kidney, but intermittent if there is temporary retention. Frequent micturition is commonly observed, but is probably due to vesical tuberculosis. There is slight albuminuria, even if the urine is clear, as is shown by the presence of a thin, opalescent zone with the cold nitric-acid

test, with a few small, white scales, but with no visible pus. The scales consist of white blood-corpuscles, held together with a little fibrin, and, as a rule, microscopical examination reveals the tubercle-bacillus. Hematuria is not abundant, and usually persists only for a few days. There may be only one or a few attacks in the beginning of the disease, with no later recurrence. The blood is intimately mixed with the otherwise clear urine. The hemorrhage comes on without apparent traumatic cause, as in pulmonary tuberculosis. Pyuria is almost constant. The urine is acid and milky; upon standing, it separates into a bottom layer of gray purée, containing streaks of blood, with supernatant opaque urine. The patient loses appetite and weight, has remittent fever, and dies in from six months to two years. In some
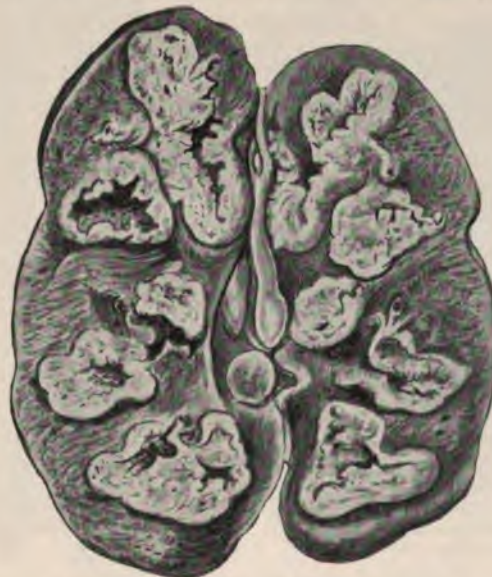
FIG. 323.—Tuberculous kidney (Rovsing).

cases, however, temporary arrest, or even definite cure by encapsulation, has been observed.

Treatment.—Internal treatment has symptomatic value only. Operation may effect a cure that will last for years.

Nephrectomy, total or partial, the latter being rarely applicable, is the operation of choice. It is applicable when the other kidney is healthy, and when the patient's condition as regards tuberculosis in other organs permits. It has, however, been seen that tuberculosis in the bladder has improved after nephrectomy. The tuberculous ureter may be excised with the kidney, if the patient's condition permits. Subcapsular nephrectomy, with curetting of the adipose capsule, has the advantage of being easy of execution; but has the disadvantage of not removing the tuberculous foci.

Nephrotomy for evacuation, curetting, and local treatment is recommended by as high an authority as Guyon, to be followed by secondary

nephrectomy when the patient's health is improved. Guyon gives the excellent advice on technic of suturing the divided adipose capsule to the skin before opening into the tuberculous kidney, in order to avoid infection of the wound.[1]

Tumors of the Kidney.—**Malignant Tumors.**—The differential diagnosis between carcinoma and sarcoma of the kidney was not made until about ten years ago; up to that time all cases were described as "cancer." The symptoms of carcinoma and sarcoma are so similar that they may be considered under the same head. Malignant tumors are more common in man than in woman, and occur in all ages. Sarcoma is more common in children; and carcinoma is more frequently met with between the ages of fifty and seventy. In 18 cases of carcinoma reported by Brodeur, 17 occurred in adults and only 1 in a child; in 27 cases of sarcoma, 15 adults and 10 children were affected; almost 80 per cent. of the sarcomata in children occur during the first four years of life, and some may even be congenital. Primary malignant disease is, of course, unilateral; when a tumor is found in both kidneys, therefore, one or both must be metastatic. The size varies from that of a hazelnut (Israel's case) to one-third the weight of the body (in a child). The tumor is either circumscribed or diffused. The circumscribed tumor extends from the kidney-substance into a calyx or into the renal pelvis, where it may cause hematuria as long as the ureter is patent; or it may perforate into the renal vein and the vena cava, causing malignant thrombosis.

Histology.—Carcinomata are not so common as sarcomata, and are usually soft, large, nodular tumors; seldom small and hard. Microscopical examination shows the structure of the tubular carcinoma from proliferation of the epithelial cells of the urinary canals. Metastases occur later than in carcinomata in other parts of the body, but earlier than in renal sarcomata; and the metastatic carcinomata are usually located in the retroperitoneal lymph-glands, the lungs, and the other kidney.

Sarcomata originate from the inside of the capsule, or from the suprarenal bodies, or from aberrant islands of their tissue located in the kidney, or rarely from the perirenal tissue. Microscopical examination reveals round-cell, spindle-cell, or mixed sarcoma, endothelioma, and rarely rhabdomyoma or myxosarcoma. The sarcomata are usually nodular, grow gradually, and may attain an enormous size.

Symptoms.—There are often no symptoms for a long time, during the so-called latent stage of the disease. Pain is often absent, is not characteristic, and is not influenced by movements or pressure. Attacks of renal colic are caused by coagula or pieces of tumor-tissue obstructing the ureter. Shortness of breath may be due to the presence of a large tumor pushing the diaphragm upward. A palpable tumor coming down from under the ribs, covered by the colon, with a tympanitic area on its abdominal surface and palpable in the lumbar region, is found later in the disease in 96 per cent. of all cases. Hematuria is a most important symptom, but is absent in one-fourth of the carcinomata, in one-half of the sarcomata, and in three-fourths of the malignant tumors in children (Tuffier). It occurs when the tumor has entered

[1] Nephrotomy, as a curative operation, is being abandoned, as not 1 of the 90 cases reported by Vigneron and Facklam was cured, and as the operative mortality was 12 per cent. or 13 per cent., making the mortality from the disease 33 per cent. to 38 per cent. On the other hand, of 88 primary nephrectomies reported by Facklam, 28.4 per cent. died and 40.9 per cent. resulted in perfect cure: in 14 cases the patient lived from two to eight years after the operation. No operation should be made when the urea is diminished below one-third of the normal.

the pelvis, is more profuse than in stone and tuberculosis, is observed, as a rule, in the beginning of the disease, may be steady for months or remittent, and may finally disappear entirely when the ureter is occluded by the tumor. Coagula may cause renal colic. Tumor-elements may be found in the bloody urine. The quantity of urine is ordinarily normal. It is, however, sometimes increased, and less frequently decreased. Emaciation and cachexia are late symptoms in the disease, possibly because the kidney is an excretory organ, and therefore evacuates the toxin with the urine (Rovsing).

Course and Prognosis.—If the patient's life is not saved by an opera-

FIG. 324.—Sarcoma of the kidney extending into the vena cava and the spermatic vein from the renal vein (Rayer).

tion, the time from the first appearance of symptoms until death, is in most cases from one to four years; but in some cases the patient may live from ten to fifteen years (Roberts).

Diagnosis.—In early diagnosis lies the only hope of saving the patient's life by extirpation. In cases without hematuria the tumor is the first indication. In children a relatively small tumor can be palpated, because the subdiaphragmatic space is flat and small, the kidney less firmly fixed, and the abdominal wall relatively thin. In adults, when the tumor begins in the suprarenal capsule or the upper pole of the kidney, it may push the diaphragm upward and attain a considerable

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size before it can be felt below the borders of the ribs; it is then, as a rule, too late to hope for a permanent cure. In the cases attended by hematuria an early diagnosis can more easily be made. A copious, sudden hematuria, initiated without trauma, pain, or other symptoms referable to the urinary organs, directs the attention to malignant tumor. In the diagnosis, tuberculosis, nephrolithiasis, and hemophilia must be excluded. If no tumor can be felt, cystoscopy or catheterization of the ureter must determine which of the kidneys is the source of the hemorrhage. If these measures fail, exploratory lumbar incision must be resorted to.

Treatment.—Nephrectomy should be made by lumbar incision in case of the smaller tumors; but the transperitoneal operation will be required if the tumors are too large to be removed through a lumbar wound. The tumor is operable if it is limited to the kidney, and if there are no metastases in the lymphatic glands. This, however, often cannot be determined before exploratory incision renders palpation of the organ possible. If it is found that enucleation cannot be completed in perfectly healthy tissue, the operation should be abandoned. The prognosis of the operation is grave. The operative mortality before 1890 was over 60 per cent., but has decreased in the last five years to 25 per cent. (Wagner). Radical cure is rare; but the instances are increasing in which a permanent good result is obtained. Israel reports 3 patients, out of 11 operated upon, who were in good health after three years. I have 1 case in which the patient is still in good health eight years after operation. Local relapses may come on later, after three years or more. Therefore, Tuffier gives six years as the time which must elapse before the patient may be said to be permanently cured.

Benignant Tumors.—Lipomata, adenomata, fibromata, angiomata, myomata, and combinations of these have been found in the kidney. In most cases the tumors are small, give rise to no symptoms, and are discovered accidentally on the post-mortem table. Benignant tumors have been removed by nephrectomy in 10 cases only; 2 of these were adenomata and 8 fibromata (Rovsing). Serous cysts about the size of a walnut, either solitary or multiple, should be recognized during operation and removed by resection.

Echinococcus-cysts are found most commonly in men, between the ages of twenty and forty; ordinarily in one kidney only, and most often in the left. There is usually only one mother-cyst, which begins in the cortical substance, causes expansion and atrophy of the kidney-tissue, and when large may extend to the abdominal cavity, becoming adherent to the colon, liver, spleen, or other organs. Finally, after one or two years, the cyst ruptures, fortunately most often into the pelvis of the kidney, and evacuates parts of its contents through the ureter.

The *symptoms* are at first vague; the tumor is globular and often movable. When rupture takes place, it is marked by a sudden pain followed by renal colic as the daughter-cysts pass down the ureter, and by vesical tenesmus when they pass out into the urethra. The cysts are usually crushed during their passage from the kidney, and we find in the urine transparent gelatinous masses (the sac-walls) and a little blood. Microscopical examination reveals the characteristic hooklets and lamellated membranes of the sac. Later on, infection comes on, attended by fever and emaciation, terminating fatally in most cases (23 out of 29, Boeckel), spontaneous recovery being the exception.

Treatment.—The cysts should be opened by lumbar or transperitoneal incision, the contents evacuated, and drainage maintained until the cavity is closed. The opening in the cyst-wall must be united to the skin. Lumbar incision, if practicable, is to be preferred. If the transperitoneal route is chosen, the operation in two stages is preferable. Le Dentu treated 9 cases and Wagner 28 cases in this manner, and all the patients recovered; while

out of 10 cases in which nephrectomy was performed Wagner reports 3 deaths ; and of 11 cases of puncture alone or puncture with injection of tincture of iodin, 3 were cured, 3 remained unimproved, and 5 died.

Aneurysm of the Renal Artery.—Rovsing reports that only 9 well-described cases of aneurysm of the renal artery are to be found in the literature. The diagnosis was made in none of these cases until an exploratory operation or autopsy revealed the true character of the disease. If the aneurysm is located in one of the large intrarenal branches, the swelling is central and causes distention of the kidney. If it is an aneurysm of the trunk of the renal artery, the tumor is located outside of the kidney (in the hilus), and pushes the kidney aside without making any change in the shape of the organ.

The *symptoms* are a rapidly increasing, tense or elastic tumor, with a feeling of heaviness and pain, which may radiate down to the testicle of the same side. Pulsation has not been noted in any of the cases. Diagnosis is practically impossible before an exploratory incision has been made. The possibility of aneurysm should be considered when, subsequent to an injury in the region of the kidney, a tumor of considerable size develops rapidly, with no hematuria, especially in patients having arteriosclerosis or syphilis.

The *treatment* is nephrectomy, after ligature of the renal vessels as close to their origin as possible. Two patients have been saved in this manner (Hochenegg, Hahn).

Cystonephrosis (*Hydronephrosis, Pyonephrosis*).—Dilatation of the urinary passages occurs above an obstruction to the free flow of urine. It begins immediately above the point of stenosis and extends gradually backward toward the kidney. Thus, a stricture of the bulbous portion of the urethra causes, first, dilatation of the membranous urethra, next of the bladder, then of both ureters, and finally of the pelvis and calyces. If the obstruction is in or below the bladder, the dilatation extends to both kidneys ; while if the obstruction is located in the ureter or above it, the dilatation will be limited to the kidney of the affected side. If only one of the two branches of the ureter is occluded, a partial dilatation of the kidney takes place, which is limited to the corresponding half of the organ. Dilatation of the pelvis and calyces above the ureter may be termed *cystonephrosis*. When no infection of the retained urine has taken place, it contains a watery fluid, and is termed *hydronephrosis*. When infection has transformed the fluid into pus, we speak of *pyonephrosis*.

Non-infected Cystonephrosis (*Hydronephrosis*).—We may classify hydronephrosis as follows:

1. *Congenital* hydronephrosis, when the stenosis is caused by intra-uterine disease.

2. *Acquired* hydronephrosis, when the retention of urine is caused by diseases late in life.

If the hindrance to the evacuation of urine is absolute, we have a *permanent* hydronephrosis; if the urine passes out at intervals, the condition is known as *intermittent* hydronephrosis.

Etiology and Pathogenesis.—Sudden, complete occlusion of the passage of urine, as exemplified experimentally by ligation of the ureter, is followed in most animals by atrophy without dilatation, and only exceptionally by hydronephrosis. In most instances in which a progressive hydronephrosis is developed, the occlusion is also gradual and for a time incomplete.

Compression of the ureter by tumors is of common occurrence. Morris states that 90 per cent. of hydronephroses are caused by malignant tumors in the small pelvis. When a carcinoma of the uterus extends into the broad ligaments, compression of the ureter and hydronephrosis result in one-half of the cases. Disease in the wall of the ureter, such as traumatic rupture, ureteritis, or tuberculosis,

may lead to stricture. Bending of the ureter, due to floating kidney, is followed by incomplete obstruction, retention, and dilatation above the bend. When the dilatation of the renal pelvis is unilateral or not uniform, lateral implantation and valve-formation of the ureter at its pelvic end give rise to retention and hydronephrosis. This condition is not uncommon. Finally, an obstruction within the canal of the ureter, such as a stone, a foreign body, or a blood-clot, may occasionally be the cause of hydronephrosis.

Congenital Hydronephrosis.—A congenital cause for hydronephrosis is found in one-third of all cases. The disease may be bilateral when the hindrance to the evacuation of urine is located in the prepuce or the urethra. Absence of the urethra or complete occlusion by a membrane at the external or internal orifice causes complete hydronephrosis.

FIG. 325.—Right congenital hydronephrosis in a child nine months old. Extirpation; recovery (Rovsing). *a*, Suprarenal capsule; *b*, ureter; *c*, valvular obstruction at the pelvic end of ureter.

Phimosis or incomplete valve-formation in the urethra causes incomplete hydronephrosis. In rare cases the cause is found to be bilateral obliteration of the ureter. Children affected with bilateral hydronephrosis die shortly after birth. Unilateral congenital hydronephrosis is compatible with life, as the other kidney is sufficient for the necessary function. This condition, therefore, is often not noticed until later in life, unless the sac at the time of birth is so large as to cause an impediment to delivery. The obstruction is most often in the ureter; rarely in the bladder.

In some cases there is obliteration of the ureter; in others compression of the ureter by anomalous renal arteries: torsion of the ureter is of rare occurrence. In most cases valve-formation at the pelvic orifice of the ureter is found as a congenital anomaly which causes hydronephrosis. In some cases other disturbances in development, such as spina bifida, pes varus, cleft palate, harelip, and imperforate anus, are found with the congenital hydronephrosis (Fig. 325).

In rare cases stenosis of the ureter at the pelvic or vesical orifice is seen. When the kidney has a double ureter, one portion patent and the other obliterated, a partial hydronephrosis or dilatation of the half of the kidney corresponding to the occluded ureter is seen.

Acquired hydronephrosis is much more common, and may be permanent or intermittent. Permanent, unchangeable hydronephrosis was found by Morris 142 times in 2610 autopsies. External compression of the ureter by malignant tumors in the small pelvis is the cause of 90 per cent. of hydronephroses. Carcinoma of the uterus which has extended to the broad ligaments compresses the ureters, causing bilateral hydronephrosis and death from uremia. Pelvic cellulitis, hematocele, retroflexions or lateroflexions of the uterus may also operate as causes. Other abdominal tumors, such as ovarian cystomata, uterine myomata, intestinal carcinomata or sarcomata may cause hydronephrosis, but ordinarily on one side only.

Obstruction within the ureter is caused by stone (11 out of 22 cases, Roberts), or by stricture due to inflammation or trauma. In

FIG. 326.—Hydronephrosis. First stage (Le Dentu).

FIG. 327.—Hydronephrosis. Second state (Rayer).

the upper end of the ureter the injury is usually due to rupture ; in the lower end, to difficult delivery and the use of forceps.

Intermittent hydronephrosis exists when the urine retained in the sac is evacuated at intervals. This is often found in case of floating kidney (Landau). When the kidney is descended, the upper end of the ureter is bent, and this causes obstruction and retention above. When the kidney returns to its place, as is the case when the patient lies down, the bend or twist is straightened out, and the retained urine is evacuated ; but in the course of time unilateral dilatation and valve-formation or fixation of the bend take place, evacuation becomes more difficult, and the hydronephrosis becomes stable.

Pathological Anatomy.—The retained urine causes, first, dilatation of the pelvis and calyces, with stasis, swelling of the kidney-tissue, and multiple ecchymoses, followed

later by edema, paleness, and atrophy beginning in the pyramids. The papillæ become flattened, and the pyramids and, later on, the cortical substance are gradually transformed into, or replaced by, connective tissue from interstitial infiltration, until finally a large multi-locular sac is formed, in which globular cavities, separated by fibrous partition-walls or annular prominences corresponding to the calyces and pyramid, alone remain. At first the kidney-substance is extended like a cap over the dilated pelvis (Fig. 326); but later on no kidney-substance can be seen on or in the wall of the large multilocular sac (Fig. 327).

The rapidity, however, with which the kidney-tissue and, consequently, the secretion of urine disappear is very variable. Krause found a thin layer of kidney-tissue, 36 cm. long by 13 cm. (14.3 by 5.3 inches) broad, spread out over the surface of the sac. It has been observed that when a hydronephrotic sac, even of enormous size, where a thin layer of kidney-tissue could scarcely be recognized, has been opened and drained, a quantity of urine from 400 to 500 c.c. daily has been secreted. If, as in Küster's case, the other kidney is absent, life is dependent upon the hydronephrotic kidney alone. It is thus evident that the kidney-substance may be spread out as a thin layer over a large surface without losing its secretory power.

The hydronephrotic sac gradually becomes adherent to the surrounding organs by chronic inflammation, so that its extirpation is rendered difficult. If the obstruction is located in the ureter, this organ is found to be dilated above the obstruction; normal or atrophied below, from disuse.

The sac contains, as a rule, a transparent fluid resembling thin urine. If active kidney-tissue is present, the fluid contains a variable amount of urea or uric acid; but if all kidney-substance has disappeared, the fluid is serous and contains albumin, but no urea or uric acid.

The **symptoms** are indistinct in the first stage of development. Pain is usually absent, and the hydronephrosis is detected only when the sac has attained a considerable size. The tumor in the renal region gradually extends from below the ribs downward into the lateral half of the abdomen, and is then often accidentally discovered by the patient. It subsequently extends downward toward the symphysis and inward to the median line, which it finally passes, until it fills the entire abdomen. The tumor is usually fluctuating, and may be felt to extend up behind the ribs and backward into the lumbar region. As the tumor is usually covered by ascending or descending colon, there is an area of clear percussion on the abdominal surface; but when the sac becomes very large, the colon is pushed far over toward the healthy side, leaving the percussion dull over the corresponding half of the abdomen. Sometimes a more firm and somewhat nodular territory is felt, which corresponds to a considerable layer of kidney-substance.

Pain is often absent, and is sometimes remittent, even in stable hydronephrosis, and may then be due to a sudden increase in the size of the tumor. In open or intermittent hydronephrosis, attacks of pain and tenderness occur during the period of accumulation. The pain and tumor disappear upon evacuation of the sac, often during the night, simultaneously with the passage of an increased amount of urine. The patient is often aware that certain positions or manipulations of the tumor aid in the evacuation. The intervals between attacks vary from four to five days to a month or more.

Fever is absent in non-infected cystonephrosis; if fever is present, it signifies infection and consequent additional danger to the kidney as well as to the patient.

The disease runs an indefinite course; and if unilateral and not infected, does not disturb the general health. Spontaneous cure is possible, but rare. It may take place, for instance, when a stone impacted in the ureter passes down into the bladder.

Infected Cystonephrosis (*Pyonephrosis*).—The contents of a hydronephrotic sac furnish an excellent culture-soil for the growth of microbes, and the low vitality of the sac-walls offers no resistance to them; therefore, when microbes once gain access to the cavity, they multiply with great rapidity. The sac-contents become purulent, the increased tension causes pain, and high fever, with rigors and all the other symptoms of acute sepsis, give warning of impending danger. If the pus is not promptly evacuated, sepsis will soon cause the death of a patient who has only one kidney to carry off the toxins, and this kidney is so overtaxed as to become the seat of a septic nephritis, which almost invariably terminates in fatal uremia. The suppuration of the sac may lead to perforation and rupture. If this takes place into the peritoneal cavity, a fatal peritonitis results. If it opens into the retro-peritoneal space, a diffuse phlegmonous inflammation (perinephritic abscess) results. Although this disease is not always fatal, it is grave, and demands prompt surgical interference.

The **diagnosis** cannot be made until a tumor is felt. In small hydronephroses the location of a fluctuating tumor in the region of the kidney, extending up under the ribs and easily palpable in the lumbar region, will lead to a diagnosis. Large tumors which fill the entire abdomen simulate, and have often been mistaken for, ovarian or other abdominal cysts. If the sac is not tensely filled, it may simulate ascites. A small hydronephrosis on the right side may be mistaken for a distended gall-bladder; on the left side, for a cyst in the spleen.

Pyonephrosis presents the acute symptoms of infection, and in the more chronic cases the patients are cachectic and emaciated.

If we always consider the possibility of cystonephrosis, and on examination of the ureters find that one is occluded, the diagnosis is reasonably certain. Aspiratory puncture and examination of the fluid are often uncertain, because in the large and old sacs none of the components of the urine exists. Puncture may be dangerous, because it may be followed by extravasation of the fluid around the sac.

Treatment.—Beginning cases of open, intermittent, non-infected cystonephrosis, when due to bending of the ureter in a floating kidney, may be treated by nephropexy, provided the bend is found to be straightened when the kidney is replaced. If no bend exists, the sac should be opened and the obstruction sought for by exploring the ureter from its pelvic origin down to the bladder. A valve or stricture may be remedied by a plastic operation, or a stone may be removed from the ureter. If it is thus possible to remove the cause, the kidney can be saved, and should be saved if secreting kidney-tissue still remains.

Infected remittent cystonephrosis (pyonephrosis) must necessarily be opened for drainage, and examined as regards the removal of the obstruction; but here the question of removal of the kidney comes up, and if suppurative nephritis, with multiple abscesses in the kidney-tissue, is found, nephrectomy should be done.

Stable, permanent, non-infected cystonephrosis (hydronephrosis) has been treated by puncture, incision, and extirpation (nephrectomy).

Rovsing has collected from the literature 92 operations for hydronephrosis, with the following results:

Operation.	Recovery.	Unimproved.	Died.	Total number of cases.
Puncture with drainage	1	2	9	12
Nephrotomy		15	13	28
Transperitoneal primary nephrectomy .	16	. .	3	19
Transperitoneal secondary nephrectomy	7	. .	3	10
Lumbar primary nephrectomy	18	. .	2	20
Lumbar secondary nephrectomy	3	. .	. .	3

It will be seen from this table that puncture, even with drainage, is insufficient and dangerous, and should be abandoned. Nephrectomy, or total extirpation of the hydronephrotic sac, has given the best results, and is the operation which should be employed in the majority of cases. Transperitoneal nephrectomy was most often performed in cases in which a large sac filled the abdomen, and a correct diagnosis was not made before the operation. If it is known that a hydronephrosis is present, the lumbar operation should probably always be done. If the hydronephrotic sac contains no secreting kidney-tissue, as is the case in most of the very large hydronephroses, nephrectomy is indicated. A large sac, which is practically valueless as to secretion, and is clad with mucous membrane, is very apt to become infected after nephrotomy and drainage. It is almost impossible in such cases to prevent infection; and Rovsing's statistics show that out of 28 cases of nephrotomy, 13 patients died. In most cases of large, stable hydronephrosis we find the other kidney sufficient for the urinary secretion. This is demonstrated by the fact that out of 52 cases of nephrectomy, only 8 patients died.

In small, recent, stable hydronephroses, however, when kidney-tissue can be recognized in the walls of the sac, and when remittent evacuation, present at first, has recently ceased, we may expect to find secreting kidney-tissue that is worth saving. Here nephrotomy should be tried, and the obstruction sought for. If the sac is too large to permit of finding the ureter, we may wait for a few months until it has retracted. During this time we must examine the quantity and quality of urine excreted daily. If the quantity is considerable, the obstruction can be sought for and remedied by a secondary operation. If no urine is secreted, secondary nephrectomy should be done.

Operations on the Kidney.—Narcosis.—The position of the patient, who lies on his side with a pillow under the costo-iliac space, causes some embarrassment of the respiratory movement of the thorax and some difficulty to the anesthetizer, because the face rests with one side on the table, thus making it difficult to watch the pupil and to manage the tongue. As to the choice of anesthetic: After the use of both ether and chloroform, albumin and cylinders or cylindroids are sometimes found in the urine. Investigations of Wood and others seem to favor the use of ether. Albuminuria followed the administration of chloroform in 11.5 per cent. of the cases, and of ether in 6.9 per cent. of the cases. Cylinders were found in 34.8 per cent. of the cases after chloroform, and in 24.6 per cent. of the cases after ether. Repeated narcoses at intervals of a few days should be avoided; thus, examination in narcosis for diagnostic purposes should not be made a short time before operation.

Treatment of the Operation-wound.—The antiseptic solutions of sublimate and carbolic acid should never be used, as both of these substances have a destructive effect on the kidney-tissue, causing respectively albuminuria and hemoglobinuria. When irrigation is called for, boric-acid solution, sterilized water, or the physiological salt solution should be used. It is also important to avoid the use of iodoform, either dusted over the wound or in the form of iodoform gauze for packing or dressing. The experiments of Stubenrauch have proved that even small quantities of iodoform applied locally on the kidney-tissue caused extensive fatty and parenchymatous degeneration of the

renal epithelial cells. General iodoform-intoxication is attended by similar extensive degeneration in both kidneys and liver. Fatal iodo-form-poisoning following nephrectomy has been reported by Israel and others. In these cases the wound-cavity had been packed with iodo-form gauze, and the autopsy showed fatty degeneration of the remaining kidney.

Incision.—Access to the kidney is had either through the peritoneal cavity (the transperitoneal method) or through the lumbar region (the extraperitoneal method). The latter operation should always be performed, when practicable, in order to avoid the danger of peritonitis.

Transperitoneal Incision.—The patient is placed on the back, and the incision is made either in the median line or laterally at the outer border of the rectus muscle. The lateral incision gives better access to the kidney. The parietal peritoneum may be united to the skin by a few sutures. After digital examination of both kidneys and ureters, the intestines are pressed over to the healthy side, held in place with gauze sponges, and the posterior peritoneum—that is, the mesocolon—is divided by a longitudinal incision corresponding to the anterior surface of the kidney. The lateral layer of the mesocolon is usually divided; but if the colon is pushed outward by the tumor, it may be more convenient to divide the medial layer of the mesocolon. The anterior surface of the kidney is now laid bare to the hilus, then the lateral border, the upper and lower poles, and finally the posterior surface are exposed. This prepares the field for the operation on the kidney.

Drainage.—If the kidney is aseptic, the advice of Terrier may be followed, who closes off the wound from the peritoneal cavity by suturing the wound in the mesocolon to the parietal peritoneum or the skin, and packs the aseptic wound with a gauze drain. If the kidney is infected, it is preferable to make a counteropening in the lumbar region for drainage (Morris), and then either to close the wound in the mesocolon and the abdominal incision separately, without drainage through the abdominal wound, or to combine anterior and lumbar drainage.

Lumbar or Extraperitoneal Incision.—The patient is placed on the side, with a pillow in the costo-iliac space, so as to increase the distance between the costal border and the ilium.

The longitudinal or vertical incision of Simon, along the lateral border of the erector spinæ muscle, is 9 or 10 cm. ($3\frac{1}{2}$ or 4 inches) long, begins over the eleventh rib, and ends midway between the twelfth rib and the crest of the ilium. It divides the subcutaneous tissue, the latissimus dorsi muscle, and the lumbodorsalis fascia. Anterior to the quadratus lumborum is a fascia covering the adipose capsule of the kidney, and by blunt separation of this fascia the lower pole of the kidney is reached. The vertical incision gives little space for operating on the kidney, and has been superseded by the oblique incision.

Oblique Incision.—The oblique incision is made from the lateral border of the erector spinæ muscle, below the twelfth rib, downward and forward, parallel to either the quadratus lumborum muscle or the linea semilunaris (Thornton, Guyon, and Tuffier), or the twelfth rib (Küster). The incision is 10 or 12 cm. (4 or $4\frac{3}{4}$ inches) long, and divides the skin, latissimus dorsi muscle, possibly the quadratus lum-

borum, the external and internal oblique, and transversalis muscles. When the retroperitoneal adipose space is reached and the kidney has been palpated, the incision may be prolonged downward and forward to the outer border of the rectus abdominis muscle, or to Poupart's ligament by extraperitoneal division of the abdominal muscles as far as operative space is required. This incision gives ample operating-space, and is applicable to most cases.

Combinations of the vertical and oblique incisions are employed by König, Bardeleben, and others, and may be of use in special cases; or to the oblique incision, if required, may be added an incision at a right angle up toward the twelfth rib or down toward the crest of the ilium.

The **operations on the kidney** include puncture, pyelotomy, nephrotomy, and nephrectomy.

Puncture with the trocar or hollow needle through the skin, for aspiration of fluid, has been done to confirm the diagnosis of a renal tumor. Transperitoneal puncture should never be made, on account of the danger of infection of the peritoneal cavity by the contents of the kidney. Extraperitoneal puncture through the lumbar region is less dangerous; but it is uncertain, and is of little value either for diagnosis or for effecting a cure, as, for instance, in hydronephrosis. When, however, the kidney has been laid bare by an incision, puncture may be made with a thin needle to search for stone in the pelvis or calyces, or fluid may be evacuated from a large sacculated kidney through a trocar or aspirator-syringe, in order to facilitate the further steps of the operation. If a large sac contains pus, infection of the wound during the extirpation of the sac may thus be prevented.

Pyelotomy, or incision of the renal pelvis, may be done for removal of fluid or stones in the pelvis. After the kidney has been laid bare through a lumbar incision, the adipose capsule carefully separated from the posterior surface of the kidney and pelvis, and the organ lifted forward and out into the wound, a longitudinal incision may be made through the posterior wall of the pelvis. It is well to insert a loop of silk on each side in the border of the incision, which must be large enough to permit the introduction of the finger to explore for stone. Stones may be felt in the pelvis or in some of the dilated calyces; or a stone may be so large that it will have to be divided before extraction. After removal of stones or evacuation of pus, the question of drainage or closure of the wound must be considered. If a stone has been removed from an aseptic pelvis, the incision in the latter may be closed by a single or double row of extramucous sutures, on the principle of the Lembert sutures in the intestine. In most cases, however, there is doubt as to the aseptic condition of the pelvis, and a drainage-tube must be inserted.

Pyelotomy, as a means of access to the pelvis, has the advantage, as compared with division of the kidney-substance, of being attended by little or no hemorrhage, and of causing no injury to the kidney-tissue. It possesses the disadvantage of giving no access to abscesses in the kidney-substance and less freedom of access to the calyces.

Many authors state that pyelotomy has the disadvantage of being almost always followed by a permanent lumbar urinary fistula. We must remember, however, that no ordinary fistula will be permanent if

the ureter is patent. The condition of the ureter should always be ascertained by exploration with a bougie or sound, or by injection of fluid; and any obstruction, whether it be oblique insertion and valve-formation or stones or strictures in the ureter, should be relieved. This may be accomplished through the wound in the pelvis or by operations lower down in the course of the ureter. After this has been done and free passage of the urine into the bladder has been secured, there is no reason why a lumbar urinary fistula should follow pyelotomy more frequently than it follows an opening into the renal pelvis through the convex surface of the kidney (nephrotomy).

Nephrotomy.—Incision through the kidney-tissue is made to evacuate pus from the kidney, calyces, or pelvis; to remove stones; or, finally, to remedy obstructions in the kidney above the pelvis. The gravity of the operation depends on the condition of the kidney-tissue. A thick layer of normal kidney-substance is extremely vascular, and its division gives rise to considerable and often enormous hemorrhage. When the kidney-substance has been destroyed by interstitial nephritis from infection and suppuration, or when obstruction has caused dilatation of the calyces (cystonephrosis), the vascularity is thereby lessened and the hemorrhage upon division is slight and unimportant.

Nephrotomy in Healthy Kidney-tissue (*Nephrolithotomy ; Bisection of Kidney*).—The adipose capsule is separated by blunt dissection, and the kidney brought well out into the field of operation by pulling it down slowly and cautiously below the twelfth rib. Exploration for stone is then made by a solid steel needle or by the fine needle of an aspirator-syringe. If the aspirator-needle detects fluid, we know that it must be in a calyx or the pelvis, and the needle is therefore left in, to cut upon as a guide. Division of the healthy kidney-tissue is accompanied by considerable hemorrhage. This cannot be stopped by hemostatic forceps or by ligatures, because they tear through the friable kidney-tissue. We must therefore resort to compression of the pedicle of the kidney or to direct compression of the kidney wound. Compression of the pedicle of the kidney—that is, the renal artery and vein—can be made by digital compression between two fingers of an assistant, or by instruments. Tuffier uses for this purpose a Péan forceps with broad jaws, covered with rubber tubing, in order to avoid injury to the vessels and secondary thrombosis. Rovsing uses a compressor similar to those used on the intestines during resection of the bowels. Direct compression of the wound-surface is made by a tampon of dry sterile gauze, against which the wound-surfaces are held firmly together. After a few minutes the bleeding is considerably diminished. This method is applicable to the smaller incisions, one-fourth to one-third of the length of the kidney; but it is insufficient when the kidney is divided through its entire length, as in bisection, when compression of the pedicle cannot be dispensed with.

Exact suturing of the kidney wound by deep and superficial sutures furnishes a good and certain method of hemostasis.

Division of the kidney-tissue is made by the knife, rarely by the Paquelin cautery. The incision should be made in the median line of the convex border; that is, longitudinally, straight into the pelvis, because here only the smallest vessels are found; and as the incision

is parallel to the uriniferous canals, the smallest possible number is divided. Thus the minimum amount of hemorrhage and of atrophy of kidney-tissue will follow. A single incision through the middle of the kidney is preferable to two incisions, one at each of the poles, as it gives the best access to the pelvis and calyces. When the pelvis has thus been opened, stones are sought for by exploration with the finger or steel sound. The narrow entrances to enlarged calyces must be dilated and all calyces examined, as stones are here often left undetected. If the pelvis contains a large stone with branches extending into the calyces, the necks of the calyces may be divided to free the stone. A large stone may be divided with a crushing forceps to facilitate removal. Ordinarily a flat sound or director can be passed around the corner of the stone to free it and lift it out. As a rule, however, the stones are small and easily removable.

The ureter should always be sought for at the bottom of the pelvis,

FIG. 328.—Bisection of kidney. Insertion of sutures (Tuffier).

FIG. 329.—Bisection of kidney. Sutures tied (Tuffier).

and a probe or bougie passed down into the bladder to make certain that the ureter is patent, that no stones are arrested in it, and that no strictures or bends exist. If the pelvis is dilated, oblique insertion of the ureter may be expected. When these conditions have been remedied, permanent fistula will not follow.

The *treatment* of the wound in the kidney-tissue depends upon the condition of the latter. If the kidney is aseptic, the wound is united by deep and superficial sutures, preferably of catgut (Figs. 328, 329). The deep sutures of heavier catgut pass through the whole thickness of the kidney-tissue, while the superficial sutures of finer catgut take in the capsule and a little of the cortical substance. The adipose capsule and the abdominal muscles are united by buried sutures. Drainage with gauze or a tube down to the kidney may or may not be made, depending entirely upon the operator's confidence in his asepsis. If the kidney is infected, or if infection is suspected, it is safer to drain either

with a tube inserted down into the renal pelvis or by packing with aseptic gauze. The latter is preferable when hemostasis is not absolutely certain.

The after-course is usually aseptic, and primary healing in from two to three weeks is common. The urine is bloody from three to seven days. Fistulæ rarely follow. In 43 cases collected by Tuffier, there were 3 deaths, 2 fistulæ, and 38 recoveries.

Nephrotomy in an Infected, Suppurating, Often Dilated Kidney (*Nephrotomy Proper*).—Lumbar nephrotomy is the operation of choice. The operation has for its object the evacuation of infected fluid (pus) or non-infected fluid in cystonephrosis, the removal of stones if present, and the local treatment of the infected pelvis and calyces. It is often an operation of necessity in a septic patient with high fever, to remove the pus and put an end to the septic absorption. The adipose capsule is exposed through the oblique lumbar incision—and in septic cases it is transformed into a thick fibrolipomatous mass adherent to the surface of the kidney. This is divided with the knife either on one of the bulging fluctuating prominences or along the convex surface by an incision 3 to 4 cm. ($1\frac{1}{4}$–$1\frac{1}{2}$ inches) long, either made directly or on an aspirator-needle as a guide. If a large infected cystonephrosis containing a considerable quantity of pus is found, it is well to evacuate the pus through a trocar, and pull the sac out of the wound with forceps before incising it, in order to protect the outer wound against infection from the contained pus. A finger is now inserted into the pelvis, while the other hand makes compression on the abdomen, to push the kidney against the exploring finger, thus making it possible to palpate the whole interior of the kidney. Stones are carefully sought for by the finger or steel sound. If the entrances to dilated calyces are narrow, they may be dilated by forceps or the finger. The object of the operator should be to transform a multilocular cavity, in which access to some of the dilated calyces is difficult, into a single or unilocular cavity, in order to facilitate drainage.

If the patient's condition permits of more than the simple evacuation of pus and insertion of a drain, as it sometimes does in non-infected cystonephrosis and in some cases of bending and valve-formation of the ureter, it is advisable to bisect the kidney by complete longitudinal division in the median line. By this means the pelvis and all the calyces are exposed, and the division of partition-walls between dilated calyces with narrow necks, for thorough exploration and evacuation of their contents, is made possible. It further permits the exploration of the ureter from the pelvis and operation on strictures or valve-formations. Bisection is preferable to a shorter incision for the division of the narrow necks of calyces, as larger vessels may be divided, which will necessitate ligature or searing with the Paquelin cautery.

The pockets in the dilated kidney and the pelvis are cleansed with sponges, in order to remove stringy pus from the walls, to which it may adhere, and also stones, gravel, and incrustations. Incomplete removal of stones was found by Tuffier to have taken place in 11.3 per cent. of 114 cases. This was caused by the difficulty of exploring a large sacculated kidney with multiple pockets.

The *treatment* of the kidney wound must be such as to secure free

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lumbar drainage for a time sufficient to cure the pyelitis. Thus, the borders of the renal wound are united to the skin. If the kidney has been bisected, the ends of the kidney wound may be united and the middle portion left open. The external wound is united at the upper and lower extremities only, leaving open the middle portion which has been sutured to the edges of the kidney wound.

Drainage of the kidney is made by packing the pelvis and calyces with sterile gauze, which may be removed in a day or two and replaced by rubber drainage-tubes. Drainage of the lumbar wound is made by gauze strips or rubber tubes on the outer side of the kidney at its upper and lower poles.

A voluminous aseptic dressing is needed to take up the pus and urine from the kidney. The quantity of urine secreted from a kidney which is to all appearances useless or destroyed may be unexpectedly very large. If this be the case, it may be necessary to change the dressing once or several times daily.

The *prognosis* of lumbar nephrotomy depends upon the disease for which the operation has been made, and especially upon the condition of the other kidney. The operation, as such, has very little danger, and may be done very rapidly, as for simple evacuation of pus. The mortality in 259 cases collected by Tuffier was as follows: Pyonephrosis with and without stone, 23.3 per cent.; aseptic cystonephrosis, 18 per cent.; tuberculous pyelonephritis, 47.8 per cent.

Transperitoneal nephrotomy should be abandoned, as it is far more dangerous and never called for. Its mortality in pyonephrosis was 50 per cent.; and in hydronephrosis 20 per cent.

A permanent lumbar urinary fistula will remain if the passage through the ureter is not free. Of 220 cases of pyonephrosis, fistulæ remained in 43 per cent., and in aseptic cystonephrosis in 66 per cent. (Tuffier).

Nephrectomy.—Total removal of the kidney may be a relatively easy operation when the organ is not enlarged and when it can easily be loosened from the surrounding tissues, as, for instance, in case of central tuberculosis or of a small malignant tumor. Commonly, however, the operation is difficult or dangerous when the kidney is considerably enlarged or is firmly adherent to the surrounding organs.

The operation is either transperitoneal or extraperitoneal; extraperitoneal or lumbar nephrectomy is the operation of choice.

Lumbar Nephrectomy.—An oblique incision is made from the outer border of the sacrolumbalis muscle, 1 inch below the twelfth rib, parallel to the rib downward and forward for about 12 cm. (4¾ inches). Exploration by the finger or hand reveals the size and condition of the kidney. If there is not sufficient operating space, this incision is prolonged or another incision at an angle to the first is made. The kidney is now isolated, and either regular nephrectomy, subcapsular nephrectomy, or nephrectomy with morcellement may be done.

Regular nephrectomy is done when the kidney can be easily isolated without much danger of injury to the surrounding organs. The size of the kidney is not important in this connection, as the incision may be enlarged to obtain space for handling the organ. Isolation must be done by blunt dissection and with only moderate force. The hand must loosen the kidney down to the hilus, care being taken not to rupture peritoneum or intestines. Palpation of the pedicle will determine whether it is free and movable or stiff and infiltrated, or adherent to the vertebral column and the adjacent soft parts. If the kidney

and pedicle are freely movable, the kidney is brought cautiously out of the wound, so that the pedicle may be inspected, and isolated ligature of the renal artery and vein is performed. This is accomplished as follows: A blunt aneurysm-needle, doubly threaded with strong catgut or silk, is inserted between the artery and vein; the thread is caught and divided; the aneurysm-needle removed, and each half of the pedicle ligated. The ends of the ligatures are cut short, so as to avoid the risk of slipping off of the ligature, which may occur by pulling on the ends if they are left long. As a matter of additional security, it is well to clamp the pedicle on the distal side of the ligature with a bent forceps, so that the pedicle may be drawn into view if there should be hemorrhage after the kidney has been cut away. The ureter should be doubly ligated and divided between ligatures. The ends of the lower ligature are left long, that the ureter may be pulled out and examined later on if extirpation is necessary, as in case of tuberculosis. The artery and vein are then divided 1 cm. (0.4 inch) distal to the ligature, and the kidney lifted out of the wound. It has been advised that a little wedge of kidney-tissue be left on the pedicle, to secure against the slipping of the ligature. This is not wise, for in most cases in which nephrectomy is indicated harm might result; in malignant tumors relapse might be caused, and in septic cases suppuration of the wound might ensue. If thrombotic tumor-masses hinder manipulation of the pedicle for isolated ligation, the pedicle may be caught in a clamp with broad blades and the clamp-forceps left on for thirty-six or forty-eight hours. At the expiration of this time, the forceps is cautiously removed by slowly opening the jaws of the forceps without making traction on it, and after a few minutes, if no hemorrhage follows, cautiously lifting the forceps out of the wound.

The great danger in nephrectomy lies in hemorrhage from the pedicle. Careful ligation should therefore be performed, and after the pedicle has been dropped, careful inspection should be made to see if there is any hemorrhage deep in the wound. If hemorrhage persists, trust should not be reposed in tamponade, which is ineffective, because there are no firm walls in the cavity against which pressure with gauze packing can be made; the wound must be revised and every bleeding point ligated.

Subcapsular Nephrectomy (Ollier).—When thick, hard, fibrous, capsular masses surround the kidney and bind it to the peritoneum, diaphragm, colon, vena cava, or other organs in such a manner that its isolation would cause rupture of these organs, incision is made through the renal capsule to the kidney-tissue. This is now loosened and peeled off by blunt dissection down to or into the pedicle, leaving the fibrous capsule. If possible, the pedicle is now ligated; if not, it is clamped by a forceps, which is left in place. This method is of use in chronic suppurative and tuberculous nephritis. After removal of the kidney, the inside of the capsule should be curetted, to remove shreds of kidney-tissue or granulation-tissue, and the cavity then packed. In case of malignant tumors, this, or in fact any, operation is useless.

Transperitoneal Nephrectomy.—The incision is median, in the linea alba, or lateral, at the outer border of the rectus muscle. The lateral incision gives better access to the kidney. The intestines are held

aside with sterile gauze sponges, and palpation of both kidneys and, eventually, of both ureters is made. The posterior peritoneum which covers the kidney is now divided on either the median or the lateral side of the colon, according to its location on the anterior surface of the kidney. The tumor is isolated by uncovering, first, its anterior surface down to the hilus, then its lateral border, next, the upper and lower poles, and finally the posterior surface. The vessels in the hilus are isolated from the ureter and ligated as described above. The ureter is then divided between two ligatures and the kidney lifted out.

Drainage and the treatment of the ureter are different in septic and aseptic cases. In septic cases, the ureter, which may become a source of infection, should not be dropped into the wound-cavity, but must be brought out to be united with the skin (Thornton), either in the lower corner of the abdominal incision or through a counteropening in the lumbar region (Morris).

Drainage of the wound-cavity may be effected through the abdominal wound or through a counteropening in the lumbar region. In the first case the opening in the posterior peritoneum is sutured to the wound in the parietal peritoneum, excluding the peritoneal cavity from the wound-cavity, which is then packed with gauze or has a tubular drain inserted into it. If lumbar drainage be preferred, a counteropening is made in the lumbar region for the insertion of a strip of gauze or a drainage-tube, over which the posterior peritoneal opening is then closed by a continuous suture. The abdominal incision can then be closed without drainage.

If the kidney is aseptic, drainage may be dispensed with and the ureter left in the wound. The perirenal or posterior peritoneal wound is closed by continuous suture; and finally the abdominal wound is united without drainage.

Accidents during Nephrectomy.—The pleural cavity may be opened if the incision is made too close to the twelfth rib. When this occurs, the opening should be rapidly plugged with a sponge and united by a continuous suture. The peritoneal cavity is often opened. If the tear is small, it is easily closed by a continuous or a purse-string suture. A large opening, with loss of substance, such as is made when part of the peritoneum is extirpated with the tumor, should be closed by suture, if possible; otherwise it should be packed with gauze. In aseptic cases there is little danger from opening into the peritoneum or pleura. Any opening into the colon, or even a denudation of its muscularis during isolation from the tumor, must be carefully closed or covered in by Czerny-Lembert sutures, and a drain inserted down to the place of suture.

Hemorrhage from the vessels of the hilus may result from cutting, from rupture during isolation, or from slipping of the hemostatic forceps or the ligatures. Rapid digital compression in the hilus, and cutting away the kidney piece by piece or as a whole, may give access to the bleeding vessel. Rupture of the vena cava is rapidly fatal.

Symptoms following Nephrectomy.—Shock is common, and is often caused by a diseased condition of the other kidney. The urinary secretion is diminished for two days; this is followed by progressive

re-establishment of the secretion, which is normal on the seventh day if the other kidney is healthy.

Operative Results.—The mortality of nephrectomy has been given by Tuffier as follows : Primary nephrectomy, 371 cases, 36.8 per cent.; lumbar nephrectomy, 200 cases, 28.4 per cent.¦ transperitoneal nephrectomy, 161 cases, 44.1 per cent.

It is natural that the mortality should depend upon the disease for which the operation was done.

Lumbar nephrectomy had a mortality of 35 per cent. in 112 cases of suppurating kidney; of 23.7 per cent. in 21 cases of aseptic collection of fluid; of 24.2 per cent. in 21 cases of tumor; and of 28.2 per cent. in 46 cases of tuberculosis.

Abdominal transperitoneal nephrectomy had a mortality of 42.2 per cent. in 53 cases of suppurating kidney; of 32.4 per cent. in 49 cases of aseptic collections of fluid; of 59 per cent. in 66 cases of tumors; and of 36 per cent. in 11 cases of tuberculosis.

In 36 cases of secondary nephrectomy, the mortality was 13.9 per cent. only, as follows : In 25 cases of suppurating kidney, the mortality was 12 per cent.; in 3 cases of aseptic collections of fluid, none died; and in 8 cases of tuberculosis, the mortality was 25 per cent.

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CHAPTER XX.

SURGERY OF THE SCROTUM AND TESTICLE.

Injuries of the Scrotum and Testicles.—Open wounds of the scrotum are comparatively rare. The great vascularity of the scrotal tissues predisposes to rapid healing. Strong retraction of the wound-margins, due to the elasticity of the scrotal dartos, and free hemorrhage, form marked peculiarities of these wounds. The great gaping of the wound, which is occasionally so wide as to expose the testicle, may be mistaken for loss of substance.

Careful antisepsis, complete hemostasis, and exact suturing of the wound-margins constitute the treatment. Wounds of the testicle readily heal by first intention under successful asepsis; prolapsed seminal tubes should be replaced and the tunica albuginea sutured. Failure of asepsis is followed by prolapse of the tubes, and may result in necrosis of the organ.

Contusions occur more frequently, and are usually accompanied by extensive extravasation of blood into the loose subcutaneous cellular tissue, forming the *hæmatoma scroti;* or by bleeding into the parenchyma of the testicle, within the albuginea—*hæmatoma testis.* The intense pain of contusion of the testis, accompanied by disposition to syncope, is characteristic. Hæmatoma scroti or testis is to be distinguished from hematocele, which is a circumscribed swelling, due to extravasation of blood into the tunica vaginalis propria testis. Subcutaneous laceration of the cord is rare, and is often followed by necrosis of the testis. The hematoma is to be treated by rest in the horizontal position, with elevation of the scrotum, cooling applications, and by gentle and methodical compression later on.

DISEASES OF THE SCROTUM.

Inflammations, like erysipelas and phlegmon, are characterized by enormous swelling of the skin and subcutaneous tissues. *Erysipelas* is comparatively rare in this part of the body; but an abrasion, a boil, an eczema, or an intertrigo may offer the atrium of infection. In delicate children it occurs as erysipelas migrans. *Phlegmon* may complicate erysipelas. Extravasation of urine and peri-urethral or perineal suppuration are the most frequent causes. Gangrene may follow either of the above conditions, or may occur as a sequel to infectious diseases, like small-pox, scarlet fever, or mumps, or after slight injuries in diabetics or debauchés.

The general **treatment** in the above conditions should be supporting and stimulating from the outset. Locally, warm antiseptic poultices or fomentations of aluminum acetate. Incisions to relieve tension and to allow the escape of pent-up septic discharges and drainage are indicated.

Elephantiasis.—See Chapter XXXIII. (on Tropical Diseases).

New Growths of the Scrotum.—New growths of the scrotum occur occasionally in the form of lipoma, fibroma, angioma, or cysts with fluid contents. Sebaceous cysts are not infrequent; sarcoma and melanotic growths are very rare indeed. Peculiar to the scrotum is the epithelioma known as *chimney-sweeps' cancer* or tar- and paraffin-cancer. Careful study seems to prove that, remotely at any rate, chemical irritants are the cause of the malignant growths. Chimney-sweeps and workers in tar or paraffin suffer for a time with itchy and moist or scabby eruptions of the scrotum. The continued irritation gives rise to papillary excrescences and warty growths, which eventually undergo carcinomatous degeneration. The lymphatics seem to become involved late in the disease; hence operations for the removal of these growths have been rather successful.

DISEASES OF THE TESTICLE AND SPERMATIC CORD.

Acute Hydrocele.—Acute inflammation of the tunica vaginalis testis propria, or acute hydrocele, is either the result of trauma (contusions, wounds, foreign bodies), or is secondary to chronic or acute inflammation of the genito-urinary organs, especially of the testis, epididymis, or prostate, or to the irritation due to infection by instrumentation of the urethra and bladder. Occasionally it is due to metastasis; more often it is the result of the treatment of chronic hydrocele. According to the exudate, we distinguish a serous, a fibrinoplastic, and a suppurative variety. The latter form is almost solely the result of trauma with infection. In acute inflammation of the tunica vaginalis, the changes met with are similar to those met with in other serous membranes. The membrane loses its smooth glistening appearance; it appears red and injected, and is covered with small flakes of fibrin rich in corpuscular elements; the cavity is filled with fluid, and the capillaries are greatly distended.

Symptoms.—Accompanied with pain and fever, the intensity of which depends upon the character and the quantity of the exudate, a roundish, oval, fluctuating swelling makes its appearance in front of the testicle. The testicle is differentiated from the exudate by its hardness and the extreme sensitiveness on pressure. In the suppurative variety the fever is higher and the swelling more painful. Occasionally an exudation takes place between the layers of the processus vaginalis funiculi.

The **prognosis** of acute hydrocele is, in the main, favorable.

Treatment.—In suppurative cases, early incision and washing the cavity with warm normal salt solution are the proper procedures; in the other varieties, puncture may be resorted to to relieve the severe pain. Usually, rest, support, cooling applications, and, after cessation of pain, gentle systematic compression with the Fricke bandage will be successful.

Chronic hydrocele, or hydrocele communis, is a disease more frequent than any other disease of the testis or its envelopes. It may be found on either or on both sides.

The **etiology,** in spite of the frequency of occurrence, is rather

obscure. Careful study will perhaps reduce its causes to three: the traumatic variety, due to bruising of the testis; the symptomatic, a con-

sequence of gonorrheal, syphilitic, or neoplastic affection of the testis; and the idiopathic, in which there is a passive exudate due to interference with the return circulation.

Pathology. — The pathological characteristic of hydrocele is the accumulation of serous fluid in the tunica vaginalis (Kocher) (Fig. 330), varying in quantity from a few ounces to many pints. As a rule, this fluid is of a light-yellow or amber color; but occasionally it has a greenish tint. It is neutral in reaction, with a specific gravity of 1020, and contains a large quantity of albumin, varying from 4.5 per cent. to 5.5 per cent. The microscope shows cholesterin-crystals and epithelial or endothelial cells, and occasionally spermatozoa. The latter are supposed to be derived from

FIG. 330.—Hydrocele testis chronica: *c*, hydrocele; *e*, testis; *d*, epididymis; *a*, direction of introduction of trocar.

some of the hydatids of Morgagni; most likely, however, they are found only when the contents of the seminiferous tubes escape into the tunica vaginalis. At first, the serous layer of the tunic shows little change; but as the disease progresses, its walls thicken and undergo in spots a calcifying or ossifying change without material alteration in its epithelial covering.

A special but not very frequent variety of hydrocele is the fibrinous —*hydrocele fibrinosa.* It is characterized by a heavy fibrinous deposit which is found in the villous ramifications upon the wall of the sac. Gradually these villous masses become more and more pedunculated, until, the pedicle giving way, these fibrinous bodies, which often contain organized connective tissue, float free in the serous fluid. In this form the walls occasionally undergo enormous thickening, which makes the recognition of their real nature difficult.

The **symptoms** are those of the gradual accumulation of fluid. The enlargement begins at the lower part of the scrotal sac and extends upward toward the abdominal ring. It is pyriform in shape, with its long diameter almost vertical. The testicle lies at the lower and back part of the egg-shaped, fluctuating, and frequently translucent tumor, which lies rather forward from the vertical axis, differing in this particular from herniæ or scrotal tumors, which remain in the perpendicular line. The cord can generally be isolated at the abdominal ring. The skin shows little change from the normal, being marked only by

enlarged veins along its surface. But for an annoying, dragging sensation, due to the weight of the swelling, the disease is remarkably free from pain. The testicular sensation is unimpaired. The swelling grows very slowly, but in its progress it reaches an enormous size, and appropriates the surrounding skin of the scrotum and penis until the latter organ is fairly buried in the tissues, its site being marked by a depression below the pubis. When the swelling is tense and the walls rigid, fluctuation is not readily made out. As a rule, however, the thrill so characteristic of fluid in wave-like motion can be elicited. There is no impulse on coughing. Translucency is frequently absent in hydroceles that are frequently tapped and contain a liberal admixture of blood. When present, it is a most important sign. To elicit it, the patient is placed before a strong light; the swelling is grasped at its lower and back part and elevated, making the skin tense; the tumor is held between the observer and the light, and the proximal end of a long urethral endoscopic tube is placed against it. The eye applied to the distal or ocular end will see the pinkish-red light shining through the swelling—an infallible sign of the presence of clear fluid in the swelling.

In the **diagnosis** of hydrocele, differentiation will have to be made from hernia, hematocele, other forms of hydrocele, varicocele, neoplasm, and spermatocele.

Hernia may complicate hydrocele, and serous exudation may take place into the sac of a hernia (*hydrocele hernialis*). The hernial sac, which, according to Clocquet, may be produced by traction of a hydrocele, generally reaches to the hydrocele. When the hernia descends lower than the upper end of the hydrocele, it usually lies behind it. To differentiate between hernia and hydrocele, it should be remembered that hernia descends out of the abdominal cavity, through the external abdominal ring into the scrotum, while hydrocele ascends from the base of the scrotum toward the abdominal ring; translucency is absent in the first, and is usually present in the latter. Introducing the finger into the external abdominal ring in hernia, we get an impulse on coughing; in hydrocele, we find the spermatic cord free, and no impulse is communicated. In the horizontal position hernia will recede, or may be put back into the cavity with the peculiar hernial slip; the hydrocele, unless of the congenital variety, remains unmoved.

Hematocele will usually be diagnosed by its more rapid growth, the history of an injury, by tapping, and by the absence of translucency. When the hydrocele contains blood, diagnosis may be difficult. The various other forms of hydrocele will be diagnosed by their behavior and shape; the hydrocele communicans, by its fluid returning into the peritoneal cavity with the patient in the horizontal position; the hydrocele bilocularis, by its hour-glass shape; the hydrocele funiculi, by its position, reaching from the internal abdominal ring to the upper pole of the testicle; the spermatocele, by its small size, position in the cord, and by recognizing the character of the fluid withdrawn with the hypodermic needle; varicocele, by the peculiar worm-like feel of its veins, and by its disappearance with the patient in the horizontal position and elevation of the scrotum.

The **prognosis** as to the spontaneous cure of hydrocele is unfavorable, except in infants.

The indications for **treatment** of hydrocele are the removal of the fluid and the prevention of its reaccumulation. The so-called palliative treatment of hydrocele aims only at the first; but only in very rare instances it is followed by a cure. The removal of the fluid is accomplished by means of a trocar and cannula. The pain of the operation is slight, and requires neither general nor local anesthesia. The patient is best put into the horizontal position, and the scrotum and surrounding parts are thoroughly cleansed with soap and water and asepticized. The scrotum is grasped with the left hand, the lower back or testicular part resting in the hollow of the hand, and the skin is drawn tight. Avoiding the large veins which course along its surface, the trocar and cannula, held in the right hand, with the index finger 1 inch or 1½ inches from the point, is plunged at the junction of the middle and the lower third into the tunica vaginalis in an upward direction, to avoid wounding the testis. It is now rotated and turned backward, to assure its end being free in the cavity of the tunica vaginalis, and the trocar is withdrawn. The escape of the fluid is aided by gentle compression, and on the removal of the trocar the little opening is covered with a small pledget of cotton and painted with aristol-collodion. No other dressing is required. In the great majority of cases gradual reaccumulation of the fluid occurs. The methods for the radical cure of hydrocele are numerous, indicating a considerable diversity of opinion as to the best means to be adopted. They may be classed under two heads: injection of irritating fluids to produce adhesive inflammation and abolition of the sac; and incision of the sac, with or without partial excision of the parietal tunic, followed by drainage, or tampon, or primary closure and drainage. When it is understood that even after incision and excision of the tunica parietalis occasional relapses occur, we do not wonder that a considerable percentage of failures follow the injection plan. The injections competing for surgical favor are the iodin and carbolic-acid solutions, the iodin injection perhaps at present being the one to which resort is more frequently made. The iodin injection should be used after withdrawal of the fluid, as described above. The undiluted officinal tincture is best, and should be used in quantity varying from 1 to 4 drams, proportionate to the size of the cavity. After injection of the fluid the cannula should be plugged, and by gentle manipulation the iodin should be brought in contact with all of the serous surface. Upon removal of the plug the iodin will flow out of the cannula. Some may remain without doing harm. Upon withdrawal of the cannula the wound is sealed with aristol-collodion and the patient put to bed. As a rule, a good deal of pain, of a nauseating character, extending to the testicles and along the cord, will be experienced; sometimes only a feeling of warmth or burning in the scrotum. Reaction generally comes on in from two to three hours. The parts become red and tender; there may be accompanying pyrexia; and the scrotum swells to its former size. It should be supported, and morphin should be given to relieve the pain. Cooling applications should not be too hastily resorted to, as the reaction often falls below the desired point. The patient usually leaves his bed in from four to six days, the swelling gradually disappearing. In old hydroceles the scrotal skin rarely returns to normal,

and a suspensory bag may be worn with advantage. Years ago, Hueter recommended the injection of a 2 per cent. to a 5 per cent. solution of carbolic acid. The writer has never had any success with it. Far preferable is the method of Levis, of Philadelphia, which is claimed to be less painful than iodin injection, more certain in its action, and accompanied by less risk of sloughing, and which allows the patient to be about during the whole course of the treatment. I have had only 1 relapse in 20 cases in which I employed it. Unless carbolic acid is used in excessive quantities, poisoning need not be feared. After thoroughly emptying the cavity, Levis (quoted by Jacobson), with a syringe which has a nozzle sufficiently long and slender to reach entirely through the cannula, injects from 10 to 20 minims of a 95 per cent. solution of carbolic acid; liquefaction should not be produced by heat,

FIG. 331.—Thickening of the tunica vaginalis propria after repeated iodin injections: *S*, thickened cord ; *E*, parts of epididymis, with sclerotized connective tissue ; *h*, testis and, over it, hydrocele (after Virchow).

but by as small a quantity of glycerin as may be required. The sclerotic thickening that occurs after repeated injections occasionally becomes a source of failure; the accompanying illustration shows clearly the extent to which this may take place (Fig. 331).

Incision, either alone or with partial excision of the sac, should be resorted to when properly made iodin or carbolic-acid injections have failed; also when the sac is very thick or rigid, when, because of suspicion of tuberculous disease, the surgeon wishes to explore the tunic, and in cases of congenital hydrocele, or when hernial complications exist. The method of incision is simple, and was revived and popularized by Volkmann. After careful disinfection of the whole scrotum, a longitudinal incision over the whole length of the tumor is made, dissecting down to the sac, followed by careful ligation of all bleeding vessels. The sac is incised to admit the finger, upon which the tunic

is split to the level of the external incision. The sac is now inspected; if fairly normal, the margins of the serous membrane are stitched to the skin, and a few sutures inserted to bring the wound-margins together, guaranteeing broad serous contact. A drainage-tube is inserted into the lower angle of the wound, and an ample compressive dressing applied. At the end of a week the patient is generally able to leave the bed. Von Bergmann recommends excision of the parietal sac in all cases, as does Jacobson, also, who, in addition, passes a pencil of silver nitrate over the visceral layer. Excrescences and granulation-masses upon the visceral tunic require removal with the sharp spoon.
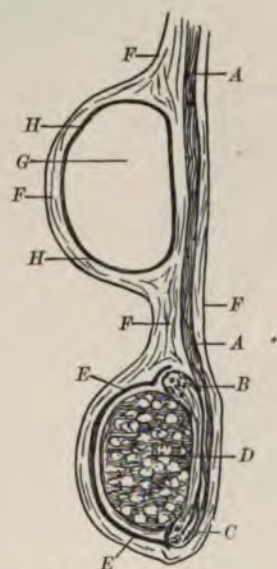
FIG. 332.—Hydrocele funiculi spermatici (cystic hydrocele) (after Lesser): *A, A*, spermatic cord; *B*, globus major; *C*, globus minor epididymis; *D*, testis; *E, E*, tunica vaginalis propria; *F, F*, external skin and subcutaneous tissue; *G*, hydrocele of the cord; *H, H*, wall of the hydrocele—the separate layers of the processus vaginalis.

FIG. 333.—Congenital hydrocele, or hydrocele communicans. Tunica funiculi communicating with the peritoneal cavity and the cavity of tunica vaginalis testis after Linhart): *a*, testicle.

Whatever dressing is applied should be unirritating, compressive, and aseptic.

Hydrocele of the cord, hydrocele funiculi spermatici or cystic hydrocele, results from a transudation of serous fluid between the separated layers of the processus vaginalis funiculi, which normally is closed. Most frequently it is of a circumscribed character, so that it forms a round cystic tumor of the cord, known as encysted hydrocele of the cord (Fig. 332). Sometimes it involves the whole length of the vaginal process, from the internal abdominal ring to the upper pole of the testicle, in which case there is generally a constriction at the external ring, giving rise to the hour-glass shaped hydrocele of the cord, the hydrocele bilocularis (Fig. 334). There is free communication of

the fluid between the two loculi. The causes of these hydroceles are similar to those of the ordinary hydrocele; sometimes they are due to trauma, rarely to gonorrhea. When the processus vaginalis closes neither at the abdominal nor at the testicular end, a serous transudation taking place into the open sac forms the hydrocele congenita or communicans. The fluid may then be slowly emptied, the patient being placed on his back, into the cavity of the peritoneum (Fig. 333).

In infantile hydrocele the vaginal process closes somewhere above the external ring, and the accumulation of fluid may simulate a hernia: it should be classed with congenital hydrocele. Hydrocele in very young babies is often cured by a single withdrawal of the fluid with a hypodermic syringe.

Among cysts, the origin of which is entirely different from those
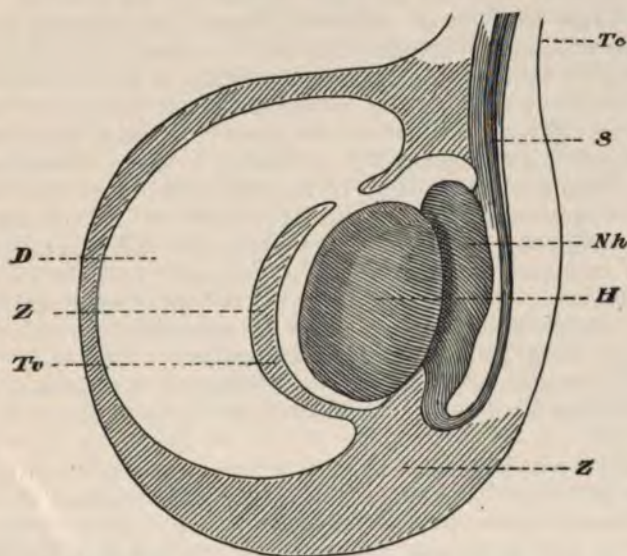
FIG. 334.—Hydrocele bilocularis (after Kocher): *Tc*, parietal layer of tumor; *S*, spermatic cord; *Nh*, epididymis; *H*, testis; *D*, cavity of diverticulum; *Tv*, cavity of tunica vaginalis propria; *Z*, inflammatory new-formation between visceral and parietal layers.

just described, but which offers great similarity clinically, is **spermatocele.** This is a cystic swelling containing spermatozoa in a fluid of a whitish, soapwater-like color. It is found at or near the point of junction of the epididymis and the testis, at the opening of the vasa deferentia into the globus major. The cyst may grow into the tunica vaginalis; but most frequently it grows upward and backward, and forms a swelling along the cord above the testis. Tapping is the treatment.

Another form of cyst of the cord or tunica vaginalis is **hematocele.** This is a collection of blood in the tunica vaginalis testis. While usually of traumatic origin, it may be due to disease, inflammatory or otherwise, of the serous membrane, analogous to pachymeningitis hæmorrhagica. It frequently forms an enormous swelling, which

in the main resembles a hydrocele; in old cases the walls are thick, the contents not fluctuating, and the swelling gives an impression of solidity.

The **diagnosis** is often made by means of an exploratory incision.

In recent traumatic cases the **treatment** by elevation, cold applications, and compression later on, may be effective. If absorption does not take place, incision of the sac, evacuation of the contents, and antiseptic irrigation are indicated. If the bleeding is caused by incurable disease of the testicle, resort should be had to castration.

Epididymitis, or epididymo-orchitis, in its acute form, is of greatest frequency in young adult life, and its most prolific cause is urethral gonorrhea. It begins usually from the fourth to the sixth week of an attack of gonorrhea, when the disease, beginning near the meatus, has travelled back toward the prostatic portion of the urethra. Violent exercise, sexual excitement, excessive drinking, very strong injections, and exposure to cold determine the attack. Later in the disease the introduction of catheters or sounds in a case of stricture have a like effect. Direct extension of the disease along the ejaculatory duct and vas deferens to the epididymis is the most reasonable explanation of the attack; metastasis, sympathy, and reflex irritation cannot be maintained as causative, in the light of modern pathology. The prostatic urethra is deeply injected and vascular; the mouth of the ejaculatory duct is deeply congested; the walls of the vas deferens are red, vascular, and infiltrated with inflammatory deposits; and the brunt of the attack is borne by the globus minor of the epididymis, which is first reached. The body and globus major are next involved, and the connective tissue between the tubes is swollen and edematous. The testicle itself is congested, but not much enlarged; the tunica vaginalis is inflamed and filled with an exudate; the scrotal tissue is red and edematous.

The first **symptom** is usually a sense of aching and a dragging weight in the testicle. The pain soon becomes severe and of a nauseating character; the patient instinctively supports the testicle, and describes the pain as passing along the cord to the groin and the lumbar region. Chilliness and pyrexia are soon added; the swelling of the epididymis and scrotum increases rapidly; the urethral discharge is arrested; fluid can be demonstrated in the tunica vaginalis; and the cord is hard and swollen. The disease reaches its height after four or five days, then gradually recedes; until after three weeks a thickening of all the tissues and a swelling in the globus minor alone remain. The disease is usually unilateral, but occasionally affects both sides successively.

The **prognosis,** as regards restitutio ad integrum, is poor; the globus minor frequently remains blocked, and permanently interferes with the function of the organ. Abscess-formation is exceedingly rare. Gangrene and peritonitis may occur when the disease affects an undescended testicle.

The **treatment** will vary with the extent and degree of inflammation. In most cases it will be necessary to keep the patient in bed. The scrotum should rest on a narrow pillow placed between the thighs, and cooling lotions, like the liquor plumbi subacetatis dilutus, tinctura

opii, or ammonium muriat., 1 dram to a quart of water, should be frequently applied. Applications of ice are most useful during the first forty-eight hours. To get the best effect, two rubber bags should be used, one to be placed under, the other above, the testicle. The ice should be crushed; the weight of the upper bag should be light— a napkin or a handkerchief should intervene between the scrotum and the ice-bag. Intense pain in robust patients may be relieved by the application of a leech or two to the cord, care being taken to keep the leech-bite aseptic. If cold applications are not readily borne by the patient, or the time for their exhibition is passed, warm fomentations may be substituted. The scrotum may be enveloped in cotton wrung out in a warm boric-acid solution. To prevent the annoyance of frequent manipulation, the cotton may be covered with oiled silk, and a Japanese stove placed upon it to supply continuous heat. The bowels should be unloaded by the administration of saline laxatives; the diet should be light and unstimulating. Puncture of the tunica vaginalis is rarely necessary. After cessation of the acute symptoms, strapping of the testicle, after the method of Fricke, will favor absorption of the exudate. A suspensory bandage should be worn for some time. Potassium iodid in 10-grain doses, given three times daily, will favor absorption of the thickening in the globus minor. Urethral treatment should be abandoned during the acute stage of the disease. As a rule, in gonorrheal cases the discharge becomes re-established with the disappearance of the epididymitis.

Chronic epididymitis may follow the acute or the subacute variety of the inflammation, or it may result from a chronic condition of the deep urethra. In the majority of cases, however, the cause of chronic epididymitis is syphilis (see Chapter XXVI., on Syphilis) or tuberculosis, the latter most frequently. Chronic tuberculous disease of the testicle, according to Treves, "may be either (*a*) primary or (*b*) secondary to tuberculous deposits in some other part or organ of the genito-urinary apparatus; or (*c*) the testicle may be affected with acute miliary tuberculosis as a part of a general disease, but this is very rare."

Acute orchitis usually occurs in combination with epididymitis, and is often the result of trauma; occasionally of inflammatory processes in the urethra, the bladder, and prostate gland. It occurs as a metastatic variety after general infectious diseases, such as typhus, variola, measles, and parotitis. Acute orchitis is always diffuse, involving the whole testis. It is ushered in by great pain and swelling, but the swollen organ retains its normal oval form. The exudate, which during the acute stage fills the connective-tissue spaces between the seminal tubes, may break down, and suppuration may follow; in the absence of infective germs, resorption takes place, leaving the organ atrophied and softened.

The **treatment** of acute orchitis is like that of epididymitis. Orchitis, when chronic from the beginning, is caused by syphilis. (See Chapter XXVI., on Syphilis.)

Tuberculous disease of the testicle usually occurs in patients between the ages of twenty and forty years; the epididymis is the part usually affected first. Injury of the testicle or previous inflammatory conditions which lower the resisting force of the tissues form the pre-

disposing causes; the presence of the tubercle bacillus in some part of the genito-urinary tract or other regions of the body is the essential cause of the disease.

Pathology and Symptoms.—In the earliest stages a small, hard nodule is found in the globus major of the epididymis, perhaps accidentally discovered by the patient, which is sooner or later followed by similar ones, until the whole epididymis is changed into a hard, irregular, nodular mass. Somewhat later some of these nodules undergo caseous degeneration, soften, and break down in one or more places, and, involving the skin, form fistulous openings or sinuses, from which a thin, cheesy material exudes. The explanation of this fact is thought to be found in the vascular peculiarities of the epididymis, viz., the extreme tortuosity of the arteries, and the division of the spermatic
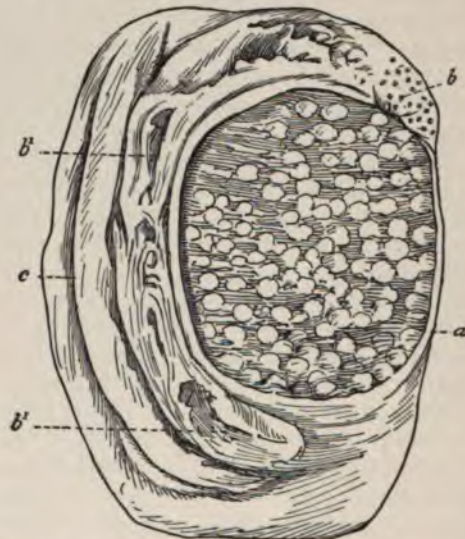
FIG. 335.—Tuberculosis of the body of the testicle and epididymis: *a*, body of the testicle studded with tubercles; *b*, enlarged epididymis; *b*¹, softened fibers and tubercles; *c*, skin of the scrotum (after Lesser).

artery opposite it into two branches, one of which becomes terminal in the epididymis. The vas deferens is thickened and indurated, irregular nodules studding its surface; it may be fairly normal along its course, but at its extremities the disease is almost always demonstrable. The affection is almost painless; the patient's general health is poor (Fig. 335).

The **diagnosis** is readily made. The nodules are to be differentiated from the hard masses often remaining after an acute epididymitis; the latter have no tendency to break down nor to form fistulous tracts, nor are they associated with tuberculous disease of the prostate or of the seminal vesicles. From syphilis, it may be differentiated by the history of the case and the inadequacy of antisyphilitic treatment. Malignant disease is marked by great pain and weight, rapid growth, and involvement of the body of the testicle.

The **prognosis** is bad in acute cases; and even in chronic cases it may eventually involve the whole organ and form the starting point for the spread of the disease along the whole genito-urinary tract.

The constitutional **treatment** is that usual in tuberculosis. The local treatment should not be too conservative. Ablation of all cheesy foci, together with the thorough use of iodoform, may check the disease, and should be tried first. If this fails, and the fungous granulations and fistulæ persist, castration should be resorted to, provided the general condition of the patient warrants the procedure.

Varicocele is the varicose dilatation and elongation of the veins of the pampiniform plexus and of the spermatic cord, accompanied by great relaxation of the scrotum. It is an affection of puberty and young manhood; in a large proportion of cases, it begins between the ages of sixteen and twenty-five years, and spontaneously decreases or disappears after middle life; very few old men are troubled with it.

Pathology.—The disease usually affects the left side. The veins of the pampiniform plexus are elongated, dilated and tortuous, much increased in number, and arranged in peculiar loops and flexuous curves. This varicose state is most marked just above the testicle; it rarely affects the veins beyond the external abdominal ring. When the disease begins before puberty, before the full growth of the testicle, it will interfere with its normal development; when it begins later, it is improbable that atrophy of the testicle is of frequent occurrence.

Causes.—Most probably varicocele is produced by the rapid developmental changes at puberty, and by the increased vascularity due to sexual excitement in veins which are anatomically predisposed to varicose changes (Fig. 336). These anatomical peculiarities, according to Treves, are: (1) their great tortuosity; (2) their great length and dependent position; (3) the constant pressure to which they are subjected by the contraction of the abdominal muscles; and (4) the very feeble *vis a tergo* with which the blood circulates through them, owing to their great length and the small caliber of the spermatic artery. The explanation of the usual occurrence of varicocele on the left side is thought to be satisfactorily furnished by the following anatomical peculiarities: (1) the greater length of the left spermatic vein; (2) its emptying at a right angle into the renal vein; (3) its position behind the distended sigmoid colon. The

FIG. 336.—Varicocele (after Curling).

disappearance or decrease of the varicocele at old age, however, detracts from the plausibility of the above explanation. More likely it is dependent upon congenital peculiarities, dissection of the cord in the fetus having shown an excess of the lumina of the veins of the left side

over those of the right side. As exciting causes, may be mentioned chronic obstipation, occupations requiring violent and frequent contractions of the abdominal muscles, masturbation, unsatisfied sexual excitement, and the nervous relaxation consequent upon these latter conditions.

Symptoms.—In weak and anemic men, varicocele causes a sense of weight and dragging, occasionally spasmodic pain along the cord, and frequently mental despondency out of proportion to the disease. The testicle may be smaller and flabbier than normal, although frequently no change in size can be found; the scrotum is loose and flabby, and, when the patient stands, the veins swell to a considerable size and feel like a congeries of easily compressible tubes or a bag of "angle worms." They are often visible through the skin.

The **treatment** is, in the majority of cases, palliative; by it, most of the symptoms are kept in abeyance, and with advancing years the trouble ceases. The patient should wear a well-fitting suspensory bandage, should bathe the parts in cold water daily, should keep his bowels in a soluble condition, and abstain from excessive sexual excitement. General tonics will be beneficial in most cases; and of extreme value is the exertion of moral control over the mental condition of the patient. When this treatment fails to relieve the patient's mental or physical distress, or to fit him for some special occupation, resort to radical cure by operation should be had. It is performed as follows: After shaving and thoroughly cleansing the operative territory, an incision, beginning 1 inch above the external abdominal ring, is carried downward to the upper pole of the testicle. The veins of the cord are exposed and must not be injured; the vas deferens, with its artery, venæ comites, and nerves, is recognized and carefully isolated. Injury of the artery (it being an end-artery) is apt to be followed by necrosis of the testis. The veins of the cord are ligated with stout catgut above the epididymis, and again at the abdominal ring, and are excised between

FIG. 337.—Sarcoma of the testicle.

the ligatures, which are now tied together, raising the testicle. The usual exudate may be drained off by a catgut string introduced at the lower angle, and the wound sutured and suitably dressed. A separate guard of cotton should be placed over the anus. Where the scrotal tissue is very lax a portion may be excised.

Tumors of the Testicle.—Solid tumors of the connective-tissue variety are not frequent; fibroma, myxoma, enchondroma, and very rarely myoma, if found, present no noteworthy peculiarities either in their histological arrangement or in their clinical characteristics.

Malignant Tumors.—Much more important is *sarcoma* of the spindle- or round-cell variety. It is most frequent at puberty and early manhood, and can occasionally be traced to an injury. The accom-

panying figure (Fig. 338) represents a sarcoma of the round-cell variety, removed by me from a man of twenty years.

Carcinoma of the testicle, which takes its origin from the epithelium of the seminal tubes (Langhans), occurs, according to the amount of participation of the connective-tissue stroma, as the hard or soft variety of cancer. The latter, the alveolar or medullary carcinoma, is much more frequent than the former, the scirrhous. Like sarcoma, carcinoma begins its development in the testicle itself, and involves later on the epididymis and the surrounding tissues. As long as it is confined within the tunica albuginea it retains its ovoid shape, but becomes irregular and bossy after having penetrated this membrane. Both sarcoma and carcinoma then grow rapidly, the skin becoming fixed and involved. Meanwhile, the lymph-vessels of the cord and the adjacent
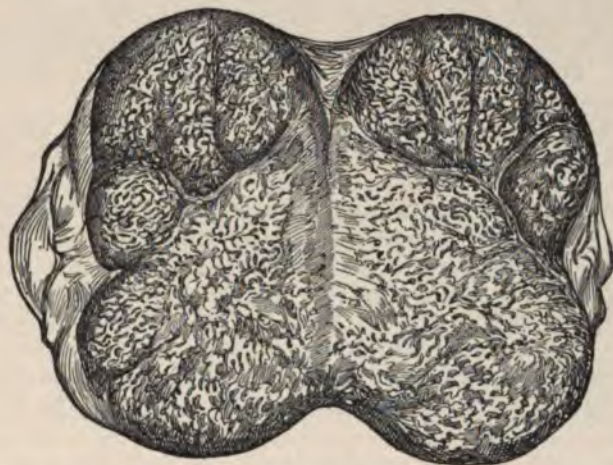
FIG. 338.—Section of sarcoma of the testicle.

glands have become infected, and metastases have formed in different organs.

In the *diagnosis* of malignant disease of the testicle, differentiation from tubercular and syphilitic disease, from hematocele and the various cystic conditions, is necessary. A careful study of the history of the cases, physical examinations, and the exploring-syringe should clear up the diagnosis.

The *treatment* of malignant disease of the testicle is by castration.

DISEASES OF THE SEMINAL VESICLES.

Inflammatory diseases of the vesiculæ seminales are undoubtedly of frequent occurrence. Their close connection with the prostate through the ejaculatory ducts makes deep urethral inflammations a prolific cause of vesiculitis. It is frequently overlooked or taken for a prostatitis.

The chief **symptom** is pain referred to the peritoneum, the groin, the lower rectum, and the lumbar region. The disease produces painful

defecation and painful and frequent micturition. According to Zeissl, "there is one symptom which belongs exclusively to inflammation of the seminal vesicles, namely, erections, which are almost constant and so painful as to constitute priapism. With the urine, blood and sometimes pus are evacuated; seminal fluid escapes at stool; spermatozoa are found in the urine, and I have observed ejaculations of a reddish-brown fluid." Examination per rectum reveals two elongated swellings by the side of the prostate, running upward and outward, at the base of the bladder. The inflammation may terminate in pus-formation or peritonitis; or, becoming chronic, may terminate in atrophy or permanent dilatation, with the formation of concretions.

The **treatment** is similar to that of prostatitis. The bowels should be unloaded and kept empty by frequent warm enemata. The patient should remain in bed; morphin should be given to relieve pain, or belladonna-and-opium suppositories introduced into the rectum; hot hip-baths give signal relief. If pus forms, it should be evacuated from the perineum. Dilatation of the seminal vesicles may produce pain, on sexual intercourse, so severe as to cause syncope.

Malignant disease—sarcoma and carcinoma—is generally secondary to prostatic or bladder disease, or is a direct extension from these organs.

Tuberculosis of the seminal vesicles, as a primary disease, is exceedingly rare; secondarily, it occurs in connection with tuberculosis of the epididymis and cord or of the bladder. The finger in the rectum may recognize in the hard, shot-like nodules of an enlarged vesicle the presence of tubercular disease. If no other evidence of tuberculosis exists, one should be careful to exclude concretions or phleboliths. If primary, the affected vesicle may be removed by the Zuckerkandl perineal incision. For secondary disease, it can hardly be a legitimate procedure.

CHAPTER XXI.

GYNECOLOGY.

CONGENITAL MALFORMATIONS.

Ovary.—An ovary may be absent as an acquired condition, it having become constricted or cut off by peritoneal bands resulting from inflammation. The ovaries, owing to arrest of development, may remain permanently rudimentary, a condition associated with uterus infantilis or uterus fœtalis. In these cases the external genitalia may be well developed.

In addition to a rudimentary form, the ovary may also be rudimentary in its structural development. If the Pflüger's tubes are imperfectly formed, normal Graafian follicles cannot be reproduced. *Supernumerary ovaries*, or, strictly speaking, an excess of the number of normal ovaries, have not as yet been noted. The cases of supernumerary ovaries reported by von Winckler and Kolks will not bear criticism. *Accessory ovaries*, on the other hand, are not uncommon, as they are found in 2 per cent. to 3 per cent. of the cases. These are detached portions of ovarian tissue produced by the subdivision of an ovary by peritoneal bands. They vary in size from 2 or 3 mm. (0.08–0.12 inch) to 1 or 2 cm. (0.4–0.8 inch) in diameter, may be pedunculated or sessile, and are usually located along the peritoneal border-line. Such accessory ovaries may be the seat of pathological processes of cystic, dermoid, or solid formation.

Displacement.—The ovary may be arrested in its descent at any point between the lumbar region and the pelvic inlet, and may occupy a position outside of the true pelvis, along the psoas muscle. In this case the tube would remain undescended with the ovary, and its length would be correspondingly increased. A similar displacement may be acquired; the ovary and tube, being raised out of the pelvis by the enlargement of the uterus during pregnancy, may acquire adhesions which will prevent their descent to their normal location during involution of the uterus. The course of the spermatic vessels, the presence of the suspensory ligament of the ovary, and the character of the inflammatory adhesions differentiate the acquired displacement from the congenital anomaly. Such an undescended ovary and tube may become the seat of pathological processes. If situated in the right side, an acute or chronic inflammation would be difficult to differentiate from an appendicitis. If bimanual examination reveal a normal uterus within the pelvis, and an absence of the ovary and tube on either side, the possibility of their non-descent or misplacement should at once suggest itself.

Instead of becoming arrested at its normal site, the ovary may continue to descend along the pelvic brim and escape from the abdominal cavity through the open canal of Nuck. This process, which is similar to the normal descent of the testicle through the inguinal canal, constitutes *hernia of the ovary*, and may be found at birth or very soon after; or it may develop at a later period. It may be either unilateral or bilateral. The tube may escape with the ovary, but it has been found herniated without the ovary. The ovary has been found in femoral as well as in obturator and sciatic hernia, although usually as a complication of inguinal hernia. In the inguinal variety, which is far the most common, the ovary may remain within the canal of Nuck or may pass through it into the labium majus. At first the ovary is usually reducible; but later on, as a rule, it becomes irreducible. In many cases the symptoms produced are so slight that the condition remains unnoticed; but in other cases a small mass is noticed, which becomes somewhat enlarged and tender at each menstrual period. The uterus is usually found inclined toward the side of the hernia, and motion communicated to it may be transmitted to the misplaced ovary. Such misplaced ovaries have no disturbance of function, as a rule. They may become the seat of inflammatory processes or of cystic or solid new-formations. Strangulation may also take place, giving rise to acute symptoms simulating in some degree intestinal strangulation. Sloughing rarely takes place, but abscesses may form. If the ovary is reducible, it may be retained by a suitable truss; if irreducible and giving rise to inconvenience, the canal may

be laid open, the ovary returned to its normal location, and the opening closed. If it becomes strangulated or the seat of pathological changes, it should be removed at once.

Fallopian Tubes.—Complete *absence* of the Fallopian tubes is found only in connection with absence of other genital organs. Absence of one tube is found in uterus unicornis. The tube may exist as a small, atrophied cord throughout its entire length, or a small section (1 cm. or 0.4 inch) of an otherwise well-formed tube may be small and contracted. An atrophied connective-tissue cord of this kind may possess a well-developed fimbriated extremity.

FIG. 339.—Fallopian tube with double fimbriated extremity.

Accessory ostia tubæ have been frequently observed. They are situated, as a rule, near the fimbriated end of the tube on its free border, are surrounded by well-developed fimbriæ, and communicate with the lumen of the tube. Conception may take place through an accessory ostium, the normal ostium on either side being closed by inflammatory adhesions. Similar conditions may be acquired (Rokitansky) (Figs. 339, 340).

Accessory tubes are not infrequently met with (4 per cent. to 10 per cent., Kossmann). They vary from a few millimeters to 1 cm. (0.4 inch) or more in length, and may

FIG. 340.—Fallopian tube with accessory fimbriated extremity or tubule: *a*, main extremity; *b*, accessory extremity.

or may not possess a lumen. They do not, as a rule, communicate with the principal tube, but may open into the free abdominal cavity, where they are usually surrounded at the end by well-developed fimbriæ. These accessory tubes may lie within the mesosalpinx; may become dilated with fluid, forming a hydroparasalpinx; or may form larger cysts, which have been mistaken for parovarian cysts. An extra-uterine pregnancy may develop in an accessory tube (see Fig. 51).

Uterus and Vagina.—The malformations of the uterus and vagina are numerous; but as the majority possess no practical surgical interest, they require only brief mention in

a general work of this kind. They are due to : 1. Arrest of development. 2. Arrest of growth. 3. Arrest of development and growth.

They are subdivided by Nagel, according to the period of development at which they occur, into the four following groups :

Group 1.   Before the formation of the genital cord.
    (*a*)   Absence of uterus and vagina.
    (*b*)   Uterus duplex separatus cum vagina separata—uterus didelphys—two completely separated uteri and vaginæ.

Group 2.   After formation of the genital cord.
    (*c*)   Uterus duplex bicornis cum vagina septa (Fig. 341).
    (*d*)   Uterus septus duplex (uterus bilocularis) and its varieties.
    (*e*)   Uterus subseptus uniforis.
    (*f*)   Uterus diforis supra simplex, with single vagina.
    (*g*)   Uterus subseptus unicorporeus.

Group 3.   During the progressive blending of the two Müllerian ducts within the genital cord and the urogenital fold, as far as Hunter's ligament.
    (*h*)   Uterus bicornis unicollis.

FIG. 341.—Uterus duplex bicornis; both sides pregnant, and laid open to show contents.

    (*i*)   Uterus arcuatus.
    (*k*)   Uterus subseptus unicollis (common body with two cavities and a single cervical canal).

Group 4.   After complete development of the uterus and vagina.
    (*l*)   Uterus fœtalis.
    (*m*)   Uterus infantilis.
    (*n*)   Uterus fœtalis imperforatus.
    (*o*)   Uterus fœtalis bicornis.
    (*p*)   Uterus incudiformis.

As the uterus and vagina are formed from bilateral parts, varieties of the subdivisions of groups 2 and 3 may be produced by an arrest of growth of one-half of the malformed organ, while the opposite half continues to increase in size relatively with the remainder of the body. *Uterus unicornis* results when complete atrophy of the arrested cornu takes place. This cornu may have various degrees of growth. It may possess a cavity that does not empty into the vagina or the well-formed cornu, although a free Fallopian tube may open into it. It may be attached to the well-formed cornu by a fibrous cord several centimeters in length.

The malformations of the first group are very rare ; and as they occur only in non-viable monstrosities, need no further consideration here.

The malformations of the second and third groups are most frequently met with. They are perfectly compatible with life, health, and reproduction, and are usually discovered

accidentally or post mortem. The sides of the uterus are usually not equally developed, and the septum of the vagina is often incomplete. Upon digital examination the septum is easily overlooked, as the external genitals give no indication of the anomalous condition within. Menstruation is normal; impregnation may occur on either side or on both sides simultaneously (Fig. 341). When one side is pregnant, the opposite side develops a decidua and menstruation usually ceases, although it has been known to continue for some time (P. Müller). Pregnancy, labor, and the puerperium are commonly passed through without unusual incidents.

If the vaginal septum interferes with the descent of the head, it should be divided. In case of abortion or other conditions requiring curettage, the operator should guard against the mistake of entering the healthy or non-pregnant side of the uterus.

Pregnancy in an imperfectly developed side of a double uterus may become a source of great danger to the life of both child and mother; the musculature, being weak, may be unable to contract so as to expel the child at term, or rupture of the uterus may occur by reason of the thinness of its walls. Rupture of the uterus may take place at an earlier period of pregnancy, simulating closely an ectopic pregnancy with rupture.

The septum vaginæ may be perfectly formed or completely absent, with an infinite number of intermediate stages. One-half of a double vagina may be rudimentary, forming a pouch which has no external opening. The accumulation of menstrual blood in this

FIG. 342.—Uterus unicornis; pregnant six months; fetus dead three months.

pouch and in the rudimentary half of the uterus opening into it produces the condition known as "*hemelytrometra lateralis.*" Should the occlusion be at the cervix without a rudimentary vagina, a simple hematometra lateralis would be produced. A hemelytrometra lateralis may rupture externally into the vagina or internally into the general peritoneal cavity, with resultant septic peritonitis.

The space at our command will not permit detailed consideration of the rarer forms of malformation of the uterus. It should be remembered, however, that arrest of development may take place at any period prior to the complete development of the single uterus.

In addition to arrest of development, an arrest of growth of the uterus and vagina or a failure to increase in size apace with the growth of the body may occur. Arrest of growth may be associated with arrest of development in its various forms. When the arrest of growth has occurred at an extremely early period, the uterus and vagina may be represented simply by a solid fibrous cord (*uterus rudimentarius solidus*). These cases are usually classed as absence of uterus and vagina. Although this is clinically true, as such a small cord may be unrecognizable upon examination, it is not strictly correct. The tubes may be of the same solid fibrous character, and the ovaries may be present, but are often imperfectly developed. The external genitalia, breasts, and female form may present the normal characteristics. All menstrual molimina are usually absent, but sexual impulses may be present.

In place of a simple fibrous cord, a more or less rudimentary vagina from one to several centimeters in length, and ending as a blind pouch of varying caliber, may be present.

In *uterus fœtalis* the uterus remains about the size and shape of the uterus of the new-born. The vagina is present, but is small and rudimentary. In *uterus infantilis* the organs remain in a rather small or infantile condition. Menstruation is usually present, although scanty. This condition is often associated with vicarious menstruation. Conception is possible when the arrest of growth is not too pronounced.

Premature development of the sexual organs, including the breasts, pubes, etc., may likewise occur. Menstruation may become established at a very early age, and pregnancy has been known to occur at the age of eight years.

Malformations of the Vagina.—Absence of the vagina, vagina rudimentaria, and vagina septa occur only in connection with corresponding malformations of the uterus, and have been sufficiently described under that heading.

Atresia, transverse and diagonal septa, and agglutination of the walls of the vagina are not congenital anomalies of development, but acquired conditions.

Malformations of the Hymen.—In complete vagina septa with double orificia vaginæ there may be a double hymen; more commonly the median edges merge together, forming a fold along the septum and giving the appearance of a single hymen. The hymen is probably never absent, although it may vary in size and in outline.

The most important anomaly of the hymen is *imperforation*, which, although very rare, may exist. The disturbances produced by imperforate hymen will be considered under atresia of the vagina. Congenital cysts of the hymen, containing a whitish or milky fluid, have been described.

Hermaphrodism.—True hermaphrodism, or the union of the two sexes in the same individual, has never been demonstrated in the human subject, and probably does not exist. So-called pseudohermaphrodism is a condition produced by various anomalies of the external genitals, and may occur in either sex. When the female sex predominates, the condition is known as *gynandria*. There is usually an hypertrophied clitoris, there may be hernia of the ovaries into the labia majora, the labia are often adherent in the midline, and the uterus and the vagina are rudimentary.

When the male sex predominates, the condition is known as *androgyna*. The testicles are retained, there is hypospadias, the urethra may open into the remains of the urogenital sinus or cloaca, which may be large enough to assume the function of the vagina in copulation, and the scrotum is imperfectly developed, forming simply loose bilateral folds. Such individuals are usually sterile.

Considerable variety in the external configuration of these patients may exist; but a careful consideration of the development of the genitalia will usually enable one to determine to which sex the individual belongs. In case of doubt, it is always safer to have the individual reared as a male.

DISEASES OF THE VULVA.

Non-infectious Diseases.—Trauma.—Contusions of the vulva in the non-puerperal state are usually of slight importance and require no special consideration. During the latter part of gestation, however, a contusion from without, or from descent of the head from within, may rupture the large venous plexuses of this region and give rise to enormous subcutaneous hemorrhages, which may even have a fatal termination. These large hematomata require free incision under the strictest asepsis, removal of all blood-clots, and ligation of all bleeding points, or control of hemorrhage therefrom by aseptic or iodoform-gauze tamponade.

Incised, punctured, or lacerated wounds from whatever cause should be thoroughly cleansed, all hemorrhage controlled, and the parts coaptated and dressed as are wounds of the soft parts in other regions of the body.

Varices.—Varicose veins of the vulva are usually associated with a similar condition of the veins of the legs. There may be simply a few enlarged tortuous veins extending over the labia and mons Veneris, or veritable varicose tumors of considerable size may develop in the labia.

The condition is always markedly worse during pregnancy, and may so improve after confinement as to give rise to but little inconvenience. A few small varicosities around the labia minora and inner surface of the labia majora may be the cause of an interminable pruritus vulvæ, especially in the aged.

Treatment.—Mild cases call for no special treatment, but where the conditions persist, giving rise to intense pruritus, pain, or inconvenience from enlargement, the veins should be removed by operation. During pregnancy no operation should, of course, be performed, unless unavoidable. During labor the veins should be carefully guarded, lest they be ruptured subcutaneously, producing an extensive hematoma, or externally, with severe hemorrhage.

Kraurosis vulvæ is a condition of atrophy and narrowing of the vulva, the result of inflammation of the skin induced by scratching on account of intense itching (Veit).

The changes found in the skin, according to Orthmann, consist in a marked atrophy of the papillary layer, the rete Malpighii being often retained only in places. The corium loses its wavy arrangement and becomes stretched and sclerosed. The horny layer is thickened, and forms scales and plates made up of many layers of cells. Surrounding the atrophied area bordering the healthy skin is a narrow, hypertrophied zone, with round-cell infiltration. As a result of the cicatricial contraction of the skin, the sebaceous and sweat-glands are mostly destroyed.

As kraurosis is usually preceded by pruritus, the etiological factors mentioned under the latter head are also instrumental. Not all cases of pruritus, however, are followed by kraurosis. The parts affected are the clitoris, vestibule, and labia minora and majora, the extent of involvement varying in different cases. It may be unilateral. The surface has a whitish, dry, contracted, roughened appearance, with occasional ectatic blood-vessels.

On account of the atrophy and contraction of the tissues, the vaginal orifice is often narrowed, interfering with coitus and offering serious difficulty during confinement. Carcinoma has occasionally developed in the affected skin.

Treatment.—If treatment directed to the etiological conditions fails, as it usually does, to give relief, the only recourse is complete excision of the diseased tissues. In this operation care should be taken not to produce further contraction of the urethra or vaginal orifice.

Elephantiasis.—True elephantiasis of parasitic origin is a disease of the tropics. What is commonly called elephantiasis is a hypertrophy of the normal structures of the region affected. The outline of the enlargement is usually not sharply defined. The enlargement may affect the labia majora or minora. Usually one side only is affected, or the condition is more marked on one side than on the other. The chorion as well as the subchorionic fibrous and adipose tissues are involved in the enlargement. The lymph-glands in the groin are commonly enlarged, and the lymph-current through them interrupted. The mass therefore presents an edematous appearance. The skin is dry, and may be smooth or rough—even warty. The affection generally appears during the active period of sexual life, and is more common in the dark races.

The clitoris alone may be greatly hypertrophied, or it may form a part of the general enlargement. The labia may be so large as to form pendulous masses hanging between the thighs, materially interfering with micturition, coitus, and even locomotion. At times the condition is painful. A history of past syphilis, together with old irritating discharges, is usually present. A tendency to ulcerate is frequently observed.

The **treatment** consists in removal of the mass by operation. Hemorrhage is often profuse, and suppuration difficult to prevent.

Tumors of the Vulva.—The most common benign tumors of the vulva are fibromata, adenomyomata, fibromyomata, and lipomata.

Fibroma.—Fibromata take their origin (*a*) from the skin; (*b*) from the dartos fascia; (*c*) from the periosteum; (*d*) from the round ligaments.

The tumors from the skin are pedunculated, and vary in size from that of a pea to that of an orange, or larger. To these the term *fibroma molluscum* is sometimes applied.

Those tumors which have their origin in the round ligaments usually contain some muscular fibers, thus forming myofibromata or even quite pure myomata. They frequently contain numerous small cysts.

Adenomyomata have been found in this location, which have their origin in misplaced remains of Wolffian bodies or Müller's ducts. The round ligament forms a cord which may often be felt extending from these tumors to the external inguinal ring.

Fibromyomata.—The other fibromata are composed of the usual connective-tissue fibers. These growths are encapsulated, and therefore enucleable. The skin is freely movable over them. They vary somewhat in firmness, are of slow growth, and painless unless bruised or injured. The proper *treatment* is excision.

Lipomata of the labia are rare. They may be congenital, forming soft, pedunculated tumors; or acquired, forming the usual subcutaneous, elastic, lobulated masses of slow, painless growth. They should be excised if large enough to give rise to inconvenience.

Cysts of the vulva are retention-cysts. The most common are cysts of the vulvovaginal or Bartholin's glands, due to an obstruction of their excretory ducts, the result of an inflammation usually, if not always, of gonorrheal origin. The cyst forms a fluctuating oval swelling, from the size of a cherry to that of a small egg, occupying the lower or posterior two-thirds of one side of the vulva, projecting more toward the mucous surface, so as to displace the rima vulvæ in a curved manner toward the opposite side. There is usually little or no pain unless there is acute inflammation; but the swelling may interfere with coitus. The contents of the cyst vary from a thick, glairy mucus to a chocolate-colored fluid, due to admixture with pus and blood.

The proper *treatment* is removal by carefully dissecting out the sac. A longitudinal incision is made through the skin of the labium down to the sac, and the latter removed, if possible, without rupture. Hemorrhage is controlled, and the wound closed by sutures. These cysts may also be treated by laying them freely open, painting the interior with a strong solution of silver nitrate or iodin, and packing with gauze. The result is not so certain nor so satisfactory as that obtained by removal.

Small cysts, from a few millimeters to 1 or 2 centimeters in diameter, are occasionally found in the labia minora, hymen, and clitoris. They are retention-cysts, which originate in the sebaceous glands, give rise to but little inconvenience, and are easily removed.

Hydrocele of the canal of Nuck may be mentioned under the head of cysts of the labia. During intra-uterine life the extra-abdominal part

of the round ligament is surrounded by a pouch or prolongation of the peritoneum, which is known as the canal of Nuck. This is usually obliterated during the latter part of fetal life, but occasionally the sac or pouch persists. Accumulation of fluid within this sac gives rise to a round or oval tumor, varying in size from that of a cherry to that of a hen's egg or even larger. The tumor is located in the upper part of the labium majus, and extends toward the external inguinal ring, which it sometimes enters.

This variety of tumor is of particular importance on account of the frequency with which it is mistaken for hernia. A correct *diagnosis* can usually be made by attention to the following points: Hydroceles develop slowly, are painless, give rise to but slight local disturbance, and that due entirely to location and size. They are irreducible, except occasionally, when the neck of the sac retains communication with the peritoneal cavity, when the sac can be emptied by squeezing the fluid back into the peritoneal cavity. The feeling is very different from that of a hernia as it slips back. They are duller on percussion, and fluctuate unless very tense. There is no impulse on coughing, except slightly when the sac communicates with the general cavity. They are not tender unless inflamed. It should be remembered that an inflamed hydrocele may produce symptoms simulating strangulated hernia; namely, pain, tenderness, vomiting, etc. A hydrocele may coexist with a hernia, the sacs being separate. An old hernial sac may become occluded at its neck, fill with fluid, and produce practically the same condition as a hydrocele of the canal of Nuck.

The proper *treatment* is to cut down and remove the sac by careful dissection. Should the sac extend up into the inguinal canal, the latter should be carefully closed by buried sutures, to guard against possible hernia. Owing to possible connection with the peritoneal cavity, the treatment by tapping and injection should be abandoned.

Venereal Warts.—What are usually known as venereal warts are non-specific growths, and should be differentiated from syphilitic condylomata. They are distinguished from papillomata by being discrete, superficial, and of rapid growth.

They appear as reddish, acuminate, sessile, or pedunculated growths on the vulva, vagina, cervix uteri, perineum, and around the anus. They are the result of venereal or unclean genital discharges; but their connection with gonorrhea, except as a predisposing cause, is doubtful.

The *treatment* consists in removal of the growth by caustics, the cautery, curet, or scissors, preceded by thorough cleansing and disinfection of the field of operation, and followed by antiseptic dressing until healing has taken place.

Urethral Caruncle.—A urethral caruncle is a small, red, vascular tumor protruding from the urethral orifice, and is usually located on the posterior wall of the urethra. It is characterized by extreme sensitiveness and pain on urination, coitus, touch, or movement.

The only satisfactory *treatment* is by extirpation of the growth with caustics or the actual cautery when it is small, or by excision and suture when it is large, care being taken, in the latter case, not to include enough of the urethral mucous membrane to cause stricture.

NON-INFECTIOUS DISEASES OF THE VAGINA.

Atresia Vaginæ.—By atresia vaginæ is meant complete occlusion of the vaginal lumen throughout a greater or less part of its extent. The occlusion is due to adhesion or organized union between the opposing vaginal walls.

Stenosis vaginæ is a partial obstruction or narrowing of the vaginal canal, due to organic changes. It has been customary to divide these cases into congenital, due to anomalies of development, and acquired, due to post-natal pathological processes.

Etiology.—Congenital atresia, in the sense of a vitium primæ formationis, does not occur. The embryological development of the vagina furnishes no explanation of transverse vaginal septa. While the occurrence of fetal adhesions between the vaginal walls, due, according to Kussmaul, to intra-uterine inflammatory processes at the time of the excessive exfoliation of vaginal epithelium, has been admitted as a theoretical possibility by some, no post-mortem findings demonstrating such a mode of origin have been presented; hence all cases of atresia vaginæ may be considered as of post-natal origin.

The cause of these obstructions, partial and complete, is to be sought in changes resulting from inflammatory processes, and cicatricial contraction following traumata.

Inflammatory processes may occur at an extremely early age. Bloody discharges from the vagina have been observed a few days after birth. Purulent discharges during childhood are not uncommon, and while such discharges usually come from more superficial parts, as the vulva and hymen, the infection may extend to the vaginal mucosa, producing a denudation of the epithelium of the border of the folds, with subsequent adhesions between opposing folds. Such inflammations may produce almost no symptoms, and often pass entirely unobserved.

Acute vaginitis, frequently of a diphtheritic character, may occur in the course of the acute infective diseases (diphtheria, scarlet fever, measles, small-pox, typhoid fever, pneumonia, and dysentery) and be overlooked, owing to the severity of the primary disease. Such atresiæ, originating at a very early period of childhood, give no indications of their presence until after puberty, when the primary cause has long since been forgotten or entirely overlooked. It is this fact which has led to the supposition that such atresiæ were congenital.

The traumata which are followed by cicatricial contraction of the vagina include those connected with labor, lacerations of the vagina by the child's head or the unskilful use of forceps, or sloughing of the vaginal wall from prolonged pressure of the child's head, and cicatrices from old ulcers. Other traumata may be mentioned, such as prolonged retention of pessaries, foreign bodies introduced for purposes of masturbation, caustics applied to induce abortion, burns, and direct injury during attempts at rape, or passionate coitus. Infection with cicatricial contraction may follow any of these conditions, producing partial or complete atresia.

Two conditions may be mentioned in this connection which, although not of the vagina proper, may induce symptoms similar to atresia; namely, agglutination of the labia minora and imperforate hymen.

Symptoms.—Stenosis or stricture of the vagina seldom gives rise to noticeable symptoms before marriage. Inability to consummate the marriage relation may lead to an investigation and the discovery of stenosis. Should the stenosis be situated high up in the vagina, it will probably not be discovered until confinement, when the examining finger detects the obstruction.

If the strictures are of the thin, annular, soft variety, they may offer no resistance to the descent of the child, and may even be permanently cured by the dilatation which occurs at that time. On the other hand, should they be hard and unyielding, occupying the entire thickness of the vaginal wall, and of considerable extent, they may interrupt labor and necessitate Cesarean section or Porro's operation to effect the delivery of the child.

The cicatricial contraction may involve that portion of the vaginal wall which is in contact with the ureter, thus obstructing its lumen and producing dilatation of the ureter above, with hydronephrosis.

Complete occlusion or atresia of the vagina is rarely discovered until puberty or the time for the establishment of menstruation. The periodical occurrence of pain and the usual symptoms of menstruation in a young girl, unaccompanied by the flow, or the gradually increasing abdominal tumor due to retained menstrual blood, lead to an investigation and the discovery of the atresia. An examination will readily determine whether the obstruction is due to imperforate hymen or to organic occlusion higher up in the vagina. A tumor will be felt above the obstruction, which will vary in size according to the amount of retained menstrual blood. The blood accumulates first in the vagina above the occlusion (hematocolpos), then the cervix, and finally the corpus uteri become distended (hematometra). Should the abdominal ostium of the tube be closed by adhesions, the tube may become distended (hematosalpinx). The occlusion of the end of the tube is due to inflammatory adhesions induced probably by an extension of the infection which produced the vaginal occlusion; hence the presence of hematosalpinx is not an indication of the congenital origin of the trouble, as has been supposed. The tubes may not be involved in the process, or one or both of them may be enlarged.

Treatment.—Thin annular strictures of the vagina may often be permanently relieved by simple divulsion. Those which are thicker and firmer should be divided in one or more places, and the mucosa carefully stitched over.

In imperforate hymen with hematocolpos, the fluid should be slowly withdrawn through an aspirator or trocar, under strict aseptic precautions. The opening in the hymen is then enlarged by incision, to prevent return of the trouble.

Occlusions high up in the vagina, when thin and membranous, may be relieved by incision, with suturing of the mucosa.

In hematometra the fluid should always be evacuated slowly, care being taken to prevent infection of the cavity.

When the vagina is obliterated throughout a considerable extent, the cavity above the obstruction can be reached only by a careful and at times laborious dissection, under guidance of the finger in the rectum and a sound or finger in the bladder, to prevent accidental

opening of these organs. The surface of the new canal should be covered with mucosa when possible. If this be impossible, plastic operations utilizing the mucosa of the labia have been successfully performed.

The canal often contracts, however, in spite of all that can be done; and the surgeon is finally forced to resort to the introduction and permanent retention of a suitable tube of hard rubber or other material to maintain the patency of the canal. This should be carefully watched, lest prolonged retention cause perforation into the rectum.

When the patency of the canal cannot be maintained, the removal of the tubes and uterus may become necessary. When hematosalpinx is combined with hematometra, the danger of rupture of the tube during the evacuation of the hematometra is great. Septic peritonitis has usually followed this accident, and for this reason it is considered by some operators safer to remove the distended tube by ventral celiotomy before evacuating the fluid from below.

Injuries of the Vagina.—Injuries of the vagina other than operation wounds may be arranged under two heads: (*a*) Those due to internal violence, such as parturition, the spontaneous expulsion of large polypoid tumors, etc. (*b*) Those due to external violence.

Injuries produced during parturition are extremely common, and will be dealt with elsewhere in this volume.

Injuries due to external violence are rare, and are usually produced by falls upon more or less pointed objects which puncture or lacerate the vaginal walls. Laceration of the vaginal wall has occurred during coitus; but this would be liable to occur only in a rigid atrophied vagina or where a marked disproportion existed between the size of the two organs.

Treatment.—Such lacerations should be thoroughly cleansed, all hemorrhage controlled, and the wound sutured. If the wound is already septic, it should be cleansed, and packed with iodoform gauze. Sutures should be dispensed with until the wound is in a healthy condition, when, if it should be necessary, suturing may be done as a secondary operation.

Cysts of the Vagina.—Cysts of the vagina may occur at any time of life, but are most commonly noted during the reproductive age. They are found more frequently on the anterior or anterolateral wall, but may be located at any point, and may be either single or multiple.

According to their origin, vaginal cysts may be divided into those arising from: (*a*) Mucous glands in the vaginal wall; (*b*) remains of Gärtner's duct; (*c*) epithelial inclusions; (*d*) dilatation of lymph-spaces.

Mucous glands are not normally, or, at least, not commonly, present in the vaginal mucosa, but they have occasionally been found (v. Preuschen, Ruge, Veit). When present, such glands may give rise to cysts from retention of secretions. These cysts vary in size from that of a pea to that of a hen's egg; they project abruptly into the lumen of the vagina, are spherical or oval in shape, slightly acuminated or flattened on top, and translucent at the thinnest part. The cyst-wall is composed of connective tissue lined with a single layer of cylindrical epithelium, often ciliated.

Cysts arising from Gärtner's duct may be much larger in size and

project into the upper lateral wall of the vagina. A rounded cord often extends from the upper part of the cyst into the broad ligament to the side of the uterus. This may occasionally be followed by a probe from the interior of the cyst. At times the cyst may be very large, extending into the broad ligament and even filling half of the pelvis, the part projecting into the vagina forming but a small portion of the entire cyst. The cyst-wall here contains, in addition to a single layer of cubical epithelium and connective tissue, a layer of muscular tissue such as is found in Gärtner's duct.

Cysts from epithelial inclusions arise from misplaced epithelial nests becoming entangled in cicatrices the result of surgical operations in the vagina, or more frequently in healed lacerations. They are usually quite small, and are lined with multiple layers of flattened epithelium such as normally lines the vagina.

Cysts from dilated lymph-spaces lined with a single layer of endothelial cells are very rare, and usually follow colpohyperplasia cystica.

The contents of these different cysts varies. It may consist of thick, glairy, transparent or brownish mucus; or of a thin serous fluid, often containing blood-cells and many desquamated epithelial cells.

Symptoms.—Ordinarily these cysts give rise to few, if any, symptoms. They may exist for many years without causing any inconvenience; rarely, one is sensitive or painful to the touch (Geyl), and may thus interfere with coitus. Very large cysts may interfere with labor or may be ruptured during the descent of the child, in which case they usually refill.

The **treatment** consists in cutting off the major portion of the cyst and overlying mucosa, and stitching the remainder of the cyst-wall to the vaginal mucosa (Schröder); or in dissecting out the cyst entirely. The latter is preferable, but in the very large cysts which extend into the broad ligament it may be difficult or impossible.

Myoma of the Vagina.—Myomata or fibromyomata of the vagina are quite rare. Histologically, they are composed of unstriped muscular tissue or a combination of fibrous and unstriped muscular tissue. Their histogenesis is not clear; but Veit has suggested their possible origin in Gärtner's duct. No adenomatous tissue has, however, yet been found in them. They are most frequently found in the anterior vaginal wall, and may be pedunculated or sessile. When small they give rise to little inconvenience, but when large they may interfere with the marital relation or with the delivery of the child at term. They may become edematous and semifluctuating, or may ulcerate, giving rise to an offensive purulent discharge.

Treatment.—When pedunculated, they are easily removed by ligating and dividing the pedicle. When sessile, they should be enucleated. Enucleation is not, however, always as easily performed as in similar tumors of the uterus. The remaining wound should be sutured, or partially sutured and packed with gauze if septic.

Vaginismus.—This term refers to a peculiar nervous affection of the vaginal outlet, characterized by contractile spasm of the vagina upon the attempted introduction of the finger, speculum, or tip of a syringe, but more especially upon attempts at coitus. It is a relatively rare affection, and is most frequently observed in young neurotic women

lately married. That variety of vaginismus which is excited by attempts at coitus is called *dyspareunia*. Vaginismus must be differentiated from the pain caused by an extremely hyperesthetic or eroded vulva, and from those cases in which mental peculiarities prevent the sexual act, no spasm being present. The condition is often accentuated when the husband is also very nervous.

The **treatment** consists in applications of 5 per cent. to 10 per cent. cocain to the vagina and vulva for fifteen minutes before coitus. The vulva may be gradually and carefully dilated by vaginal plugs more or less constantly worn. Gentle attempts at coitus by the husband should be encouraged for some time, as even imperfect intercourse may be followed by pregnancy, which is an almost certain cure for the condition. Should these means fail, forcible dilatation under anesthesia, deep lateroposterior incisions of the vulva, or incision or total removal of the hymen, followed by the almost constant wearing for a few months of a vaginal glass or hard-rubber plug, may be resorted to.

SEPTIC PELVIC INFECTION.

The *cause* of pelvic diseases is usually the introduction of virulent micro-organisms from without by way of the vulva and vagina. The same elements find their way to the pelvic organs through the circulation or from the intestinal or urinary tract, but this is unusual. As the infection progresses, it affects any or all the parts with which it is brought in contact, and produces lesions which have received special names based on anatomical location, and these names have in the past been in common use. Explanatory terms affixed to the anatomical names, and based upon the etiology, pathology, or special characteristics of observed cases, assist in making the nomenclature plain and comprehensive, if not scientific. Disease in the genital organs progresses, as in other parts of the body, by way of the blood-vessels, lymph-channels, or by contiguity.

Vulvitis, Vulvovaginitis, Vaginitis, or Colpitis.—As pathogenic bacteria, in the large majority of instances, are introduced from without by way of the vulva and vagina, it is but natural that these parts should become frequently diseased. The vulva, because of its extremely thin and delicate mucosa and its generous supply of gland-duct openings, is almost unavoidably affected; while the vagina, with its thickened epithelium so closely resembling the skin, but without hair-follicles or sweat-glands, frequently escapes. Non-pathogenic, and even pathogenic, bacteria are found at all times in the vagina; but various conditions, such as acid secretions and the secretions resulting from other bacteria, lack of oxygen, etc., prevent the development of their virulent effects. During infancy and pregnancy, when the vaginal mucosa is softer and more congested, the vagina is much more frequently affected. During menstruation and following miscarriage or labor, when the vaginal secretion is only slightly acid or alkaline, there is much greater danger of infection. Again, about the menopause and thereafter, when atrophy of the vagina is progressing, vaginitis is frequently observed. Any agency which softens or destroys the vaginal epithelium becomes naturally a prominent etiological factor. Common

among these is uncleanliness, the wearing of pessaries, carelessly given or too frequent douches, irritation of the parts by scratching, violent coitus, stagnation of discharges from uterine diseases, etc.

The **symptoms** of vulvitis and vaginitis are a sense of burning and heat in the external genitals, a mucopurulent discharge, usually pain and scalding on urinating, and often irritation of the immediately adjacent integument with intense itching. These symptoms vary in the different forms of the disease, and with the intensity and acuteness in the individual case.

Diagnosis.—In vulvitis the labia and adjoining parts are hot, red, and swollen, and are bathed in mucopurulent discharges, while pus can usually be squeezed from the vulvovaginal glands by gently pressing the outlets of the ducts from within outward.

The discharge in vaginitis must be differentiated from that of cervical and uterine origin, which simply passes through the vagina. This can best be done by observing the character of the vaginal mucous membrane, which is often rough and granulating.

Simple or *catarrhal vulvitis* and *vaginitis* are terms limited to non-specific infection. Because of the discharge, it is called catarrhal; and because it is very common, and is often mild in character, it is termed simple.

Gonorrheal vulvitis and *vaginitis* are due to infection by the gonococcus of Neisser. In an acute case the symptoms are well defined, and reach their maximum intensity in a few days. Although the acute stage passes over in two or three weeks, the disease, unless successfully treated, may last indefinitely. When apparently cured, re-infection may occur from the vulvovaginal or Bartholin's glands, or from the cervical canal or uterus. Non-specific so closely simulates gonorrheal vulvitis and vaginitis that demonstration of the gonococcus is necessary for a positive diagnosis.

Diphtheritic or *pseudo-diphtheritic vulvitis* and *vaginitis* refer to those varieties characterized by the presence of patches or membranes. Most cases described as diphtheritic are the result of necrosis caused by streptococci and the commoner bacilli. A few, however, have been reported in which the presence of the typical Klebs-Löffler bacillus has been demonstrated. They almost all occurred in recently delivered women who had been exposed to diphtheria.

Emphysematous vaginitis is a rare form characterized by the presence in the mucosa of small cysts containing gas.

Aphthous vaginitis is observed particularly in pregnant women, and is recognized by the shedding of small white flakes from the vaginal wall.

Infantile vaginitis, a term which is commonly employed, conveys the erroneous impression that it is a distinct variety. Vaginitis in children is frequently due to the gonococcus, is attended by a very profuse discharge due to the tender character of the mucous membrane, is very difficult to cure, and may be followed by atresia.

Senile vaginitis occurs at about or after the menopause. It is attended by a very offensive, irritating discharge, usually leads to the formation of ulcers, followed by atresia, and is often mistaken for malignant disease.

Diabetic vulvitis or *vaginitis* is that form which occurs in diabetic patients, and is due to the irritation caused by fermenting urine. It is characterized by intense itching.

Treatment.—Acute vulvitis and vaginitis may occasion such distress that rest in bed may be required. These cases are best treated by hot, weak, boric-acid fomentations over the vulva, hot, prolonged hip-baths, followed by painting the surfaces affected with 5 per cent. cocain solution by means of a large camel's-hair brush, the mucopur-

ulent discharge having first been carefully wiped away. After this treatment has been kept up for a few days, more active remedies can be borne.

Perfect cleanliness and mild astringent vaginal injections and vulvar washes are generally all that is required. Strong solutions and caustics are seldom advisable, as they may lead to atresia from cicatricial contraction. Weak watery solutions of 1 per cent. of borax, boric acid, lead acetate, tannin, alum, zinc sulphate, corrosive sublimate 1 : 5000, carbolic acid 2 per cent., potassium permanganate 1 : 2000, and other agents having a similar effect, will cure the great majority of curable patients, it being understood that whenever possible the cause is first to be removed.

Pruritus Vulvæ.—This condition is termed by some authors dermatitis ; by others it is considered a neuritis. The characteristic symptom is intolerable itching, which affects all the external genitals or only well-defined areas, usually around the clitoris or the labia minora. This itching is often so intolerable and the disease so difficult to cure that life is made a burden to the afflicted. With the exception of abrasions produced by scratching, few signs of the disease are visible, but a slight thickening in the skin of the parts affected can often be seen. Pruritus is occasionally seen as a complication of disease of the uterus or rectum, and is a common accompaniment of diabetes.

Treatment.—The ordinary form of treatment by astringent, caustic, or hot and cold applications usually affords only temporary relief. Dilute menthol or 5 per cent. cocain solution may be useful, but a very strong solution of carbolic acid (50 per cent. to 90 per cent.) or camphorated phenol lightly applied is far more satisfactory.

When all complicating conditions have been removed and local treatment has been employed without relief, a cure can ordinarily be effected by complete removal of the affected parts of the skin of the genitals. The loose cellular cushion beneath usually permits easy coaptation of the remaining skin-tissue.

DISEASES OF THE UTERUS.

Septic Diseases of the Uterus.—When sepsis attacks the uterus, its usual progress is from below upward by contiguity, affecting the mucosa first. If the infection is not too virulent, a wall of exudate soon impedes further progress, and the patient is left with a so-called endometritis. If, as is sometimes the case, the disease is arrested at the internal os and affects only the cervical canal, it is called endocervicitis. The distinction between acute and chronic endometritis and endocervicitis is fanciful, as it is simply a question of severity and duration. That there is an immense difference in the acuteness of symptoms and rapidity of development of various cases cannot be denied ; but it remains to be proved that the acute and chronic forms possess essential pathological differences. The same micro-organisms may produce an acute form in one and a chronic form in another patient ; or in the same patient chronic metritis or endometritis may follow an acute attack ; or an acute condition may, without discernible cause, supervene during the course of chronic disease.

Etiology and Pathology.—Endocervicitis, endometritis, and metritis, both acute and chronic, occur as the result of the invasion of virulent micro-organisms. The uterine cavity in perfect health contains no micro-organisms, but is sterile. The occasional finding of pathogenic germs in the scrapings of apparently healthy uteri demonstrates the

FIG. 343.—Tuberculosis of the uterine mucosa, showing tubercles with giant cells (× 65).
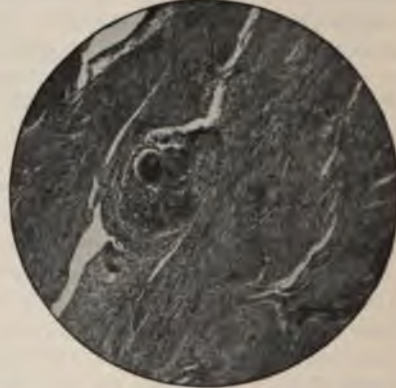
FIG. 344.—Tuberculosis of the muscular coat of the uterus (× 65).

importance of etiological factors as contributory to the development of the disease. The same surgical rules that apply to other parts of the body apply to the uterus. Sepsis begins its ravages when, in the presence of germs, the circulation is impeded or drainage interfered
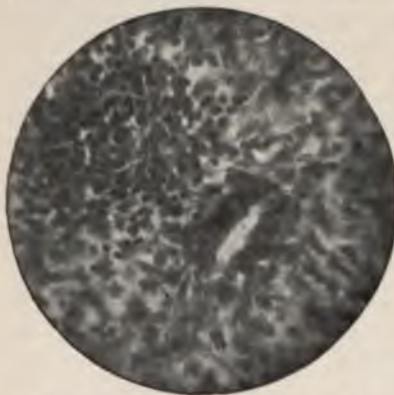
FIG. 345.—Endometritis interstitialis, showing dense inflammatory infiltration to the left, a small compressed uterine tubule to the right (× 250).

FIG. 346.—Endometritis glandularis hypertrophica; invaginated gland (× 65).

with, or when there is a breach in the continuity of tissues. The gravity of the process depends upon the virulence of the invading agent and the extent of the contribution of these etiological factors. Most prominent among these may be mentioned the congestions and lacerations of pregnancy, the congestions caused by displacements of

the uterus or pressure of neoplasms, the retention of lochia, blood-clots, etc., in the uterine cavity, and trauma. Beyond this it may be said that the ordinary germs of suppuration (the Staphylococcus pyo-genes aureus) generally cause the so-called catarrhal subacute and chronic forms of endometritis and metritis. The gonococcus produces gonorrheal endometritis.

The streptococcus, with its destructive tendencies, travels in all directions, attacks all tissues, by all channels, and is mainly responsible for the miscellaneous acute, suppurative, virulent pelvic infections which find their original foci in endometritis and metritis.

The endometrium or the muscular structures of the uterus may be the seat of tuberculosis caused by the tubercle bacillus and character-ized by the usual anatomical findings (Figs. 343, 344).

As mixed infection, in which these and other pathogenic germs may be elements, is common in pelvic infection, the difficulty of describing pure types of the various forms can be readily recognized (Figs. 345, 346).

Diagnosis.—Endometritis is recognized by a purulent discharge from the uterine cavity. The positive diagnosis of the type can be made only by microscopical examination of the scrapings. As the disease interferes with the proper physiological function of the uterus, all disturbances of function of this organ are constantly and often erroneously attributed to endometritis. Endometritis is not necessa-rily attended by pain, neither does it always produce great tenderness; but it is doubtful whether pus can issue from a uterus not affected by endometritis.

Metritis is recognized by the presence of endometritis together with enlargement, and is generally attended by pain in the uterus. The density of the uterine tissue is usually proportionate to the chronicity of the disease. These conditions may remain stationary for years, or may result in hyperplasia and sclerosis in the course of a few months, by proliferation of connective-tissue cells.

When chronic metritis follows confinement or miscarriage, it is termed subinvolution.

Prognosis and Treatment.—A reasonable proportion of cases of endometritis recover. A few of the patients who have chronic metri-tis recover; but when the disease has reached the stage known as chronic hyperplasia and sclerosis, it is incurable; that is, perfect physiological function to the extent of normal pregnancy cannot be re-established. Endometritis alone is attended by no special pain beyond a sense of weight and pressure in the pelvis. It may, how-ever, produce most severe dysmenorrhea. When associated with metritis and enlargement, the pain varies from a mere backache to a constant pain in the pelvis, which, when accompanied with severe dys-menorrhea, makes life a torture.

Endometritis and metritis are in themselves rarely dangerous. The rare, acute, suppurative, or gangrenous forms of the puerperal variety are ordinarily phlebitis rather than metritis. A woman may have endometritis, with purulent leukorrhea as a symptom, for many years, and yet in other respects be in perfect health.

Endometritis is a most difficult disease to cure. Patients often

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recover without known reason; but after apparent cure the disease will often recur. All forms of astringents, in solutions of various strengths up to the most powerful caustics, such as carbolic acid, iodin, zinc chlorid, sodium nitrate, etc., have been employed, but no reasonably efficient application has yet been found.

If the following principles are borne in mind, at least average success will be attained: The uterus in endometritis is an open, infected wound; therefore it should be dilated, cleansed, drained, and thereafter kept in as nearly an aseptic condition as possible. The chief difficulty lies in accomplishing these results. To inject liquids into the undilated uterus is often dangerous, because of its communication with the abdominal cavity. To enter the uterine cavity without perfect asepsis is equally dangerous. Simple clean dilatation and curettage of the uterus constitute the most successful method of treating endometritis; but these apparently simple procedures are frequently followed by bad results, because of mistakes in diagnosis or the failure to carry out proper aseptic precautions. It is not always possible to avoid mistakes in diagnosis, because the tubes and even the pelvic peritoneum may be affected without palpable lesion.

Dilatation and Curettage of the Uterus.—This operation is important, and should always be performed at the patient's home or at a hospital; it should be followed by at least one week of rest in the recumbent posture. Gradual dilatation of the diseased uterus in the surgeon's office is dangerous, and should never be practised. Dilatation without anesthesia, by the use of sponge, tupelo, or laminaria tents, is permissible, because the resulting dilatation is more complete
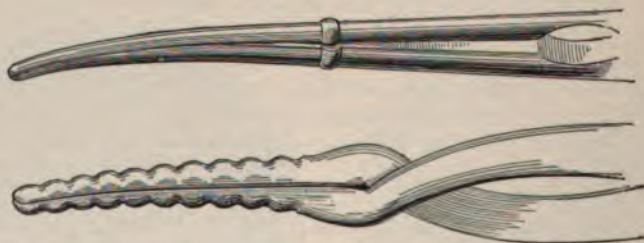
FIG. 347.—Blades of uterine dilators: the small, curved dilator is for preliminary dilatation when the os is small; the larger instrument is for further dilatation.

and more permanent; but as it is not free from risk, the patient should remain under the closest observation, so that the tent may be withdrawn at the first appearance of dangerous symptoms.

The least dangerous and usually most satisfactory method is rapid dilatation with clean steel instruments under perfect aseptic precautions and in narcosis. In puerperal patients the cervix is frequently so easily dilatable that anesthesia may be dispensed with. The dilators shown in Fig. 347 are among the best.

For curettage, a simple sharp spoon is ordinarily all that is required; although in a large, recently pregnant uterus a dull spoon or the finger may be used with less risk. The internal surface of the uterine cavity should be gone over methodically a number of times. Large uteri

may be washed out during the puerperium with weak antiseptic solutions through a large, double-current irrigator; but corrosive sublimate should never be used for this purpose. A large, thin-walled uterus may often be advantageously packed with gauze for twenty-four to thirty-six hours, in order to stimulate uterine contractions; but no packing should ever be forced into a small, thick-walled uterus. After dilatation and curettage, the greatest care should be taken to maintain the utmost possible vaginal and vulvar cleanliness until the next menstruation.

Acute metritis is best treated by absolute rest in bed, laxatives (frequently repeated), very hot douches, and sitz baths, combined with a very light diet.

Chronic metritis is cured with great difficulty. Amputation or a thorough Emmet operation on the cervix may possibly cure an occasional patient, or at least mitigate her sufferings. In addition to this, a visit to thermal springs, change of climate, massage, regulation of the bowels, etc. are often recommended.

Very rarely, an acute metritis may become so dangerous, or a chronic metritis so troublesome, that we are warranted in performing hysterectomy.

Invasion of the Genital Tract beyond the Uterus (*General Infection; Phlebitis; Thrombophlebitis*).—Blood-contamination without localization is referred to on page 637.

In certain cases septic infection is arrested by the formation of a thrombus, which gives rise to phlebitis and periphlebitis. This condition may be so extensive as to involve all the peri-uterine veins. Clinical experience has apparently demonstrated that in such cases, if suppuration does not occur, a foundation is frequently laid for atrophic sclerosis, the result of interference with the tortuous circulatory apparatus of the uterus.

In non-suppurative cases, when the thrombosis involves the uterine sinuses without extending to the peri-uterine venous circulation, hyperplasia and hypertrophic sclerosis frequently result.

When the process is acute and general, involves the entire venous plexus, and is sufficiently prolonged, gangrene of the uterus may follow, although this rarely occurs.

Treatment.—When the patient escapes general infection and neither suppuration nor gangrene occurs, local surgical treatment is unnecessary. If suppuration results from peri-uterine phlebitis, peritoneal infection is almost certain to follow. If localization does not take place, general peritonitis results; otherwise a doughy mass can usually be felt contiguous to the uterus, and free vaginal incision, with drainage, may avert an impending calamity. When such a mass, which cannot be well outlined by vaginal palpation, can be felt through the abdominal wall, it is evident that the best course is to make a suprapubic incision and drain.

When a large, doughy uterus can be felt and the patient has grave constitutional symptoms, gangrene of the uterus may be suspected; but it cannot be positively diagnosed, as the cervix does not participate in the destructive process. Under such circumstances an abdominal incision is advisable for the following reasons: (*a*) The establishment

of a diagnosis; (*b*) the diagnosis being made certain, hysterectomy is the only recourse. This operation is more quickly and simply accomplished through the incision already made. In addition to this, in case of a gangrenous uterus, more perfect hemostasis can be made by the abdominal route.

DISEASES OF THE FALLOPIAN TUBES.

Neoplasms.—Primary true neoplasms of the Fallopian tubes are not frequently met with, although they are not so rare as was formerly supposed. These new growths may be divided, according to their point of origin, into those which arise from the tubal mucous membrane, those which spring from the muscular coat, and those which take their origin from the subserous tissue.

Polypi of the mucous membrane are sometimes found in the interstitial part of the tube, and may be instrumental in causing tubal pregnancy. In addition to the true mucous polypi, decidual polyps have been observed, and a few cases of papilloma have also been recorded. These tumors are all benign.

Carcinoma is the most frequent of the malignant primary neoplasms of the tubal mucosa; sarcoma is very rare. The tubal cancers are of the tubular adenocarcinoma type, and are very soft, so that they may be termed medullary cancers. A tube the seat of such a tumor, enclosed at its abdominal end, may be and has been mistaken for a pyosalpinx. The malignant growths just described as tubular adenocarcinomata have been classified by some authors—J. Bland Sutton, for instance—as adenomata.

As a rule, only one tube has been found affected; but occasionally bilateral carcinoma of the tubes has been observed. Rarely, the ovary of the same side is also the seat of a carcinoma which has spread by contiguity from its primary location in the tube. In all reported cases of carcinoma of the tube, it has been observed that the latter has been the seat of a chronic inflammatory process prior to the appearance of the malignant neoplasm.

The age of predilection is between forty and fifty years.

The *symptoms* usually associated with carcinoma of the tube are pain in the region of the tumor, radiating down the thigh of the same side; irregular menstruation; menorrhagia; intermittent vaginal discharges of a bloody, watery, or mucopurulent character; prominence of the abdomen, which subsides temporarily after each of these discharges; finally, emaciation, loss of strength, and cachexia.

Physical examination reveals a tumor in the region of the tube or ovary, distinct and separate from the uterus, and usually painful on pressure.

Carcinoma of the tube may be differentiated from an ovarian growth of the same size by the fact that the latter is generally more or less spherical, and the former cylindrical, sausage-shaped, or fusiform.

The *prognosis* of carcinoma of the tube is, of course, grave; although a few cases have been reported in which permanent recovery is alleged to have followed timely operation. In one case death from

peritonitis occurred in consequence of spontaneous rupture of a carcinomatous tube.

Other malignant tumors of the tubal mucosa are sarcomata and syncytiomata. Both of these varieties are, however, extremely rare.

The muscular coat of the tube may be the seat of myomata, fibromata, and fibromyomata.

The tissue below the peritoneal covering of the tube, the subserosa, has occasionally, in case of fat women, been the seat of lipomata.

Infectious Diseases of the Fallopian Tubes (*Salpingitis; Pyosalpinx; Chronic Hyperplasia; Hydrosalpinx; Hematosalpinx; Tuberculosis*).—From a clinical standpoint, acute salpingitis is scarcely known. This is not because the condition does not exist, but because in its early stage it presents no symptoms beyond those common to the

FIG. 348.—Hydrosalpinx and cystic ovaries (McMurtry).

pre-existing disorder of the uterus. In the common forms of endometritis, the disease is subacute, of slow progress, and, until the later stages, the interstitial portion of the tube alone is affected. In puerperal cases due to the streptococcus, the tubal disease is only a part of the general pelvic infection, and can hardly be described as a distinct affection.

The only really distinct form of acute salpingitis is the *gonorrheal endosalpingitis* which is occasionally seen; and this condition is discovered only in the rare cases in which the rapid march of the disease allows the pelvic peritoneum to be invaded before closure of the abdominal end of the tube occurs. In such cases acute symptoms demand early interference, and operation occasionally discloses an acute gonorrheal salpingitis. Generally speaking, salpingitis is practically a chronic disease. When it affects the mucosa, it is almost

always of gonorrheal origin. The march of gonorrheal salpingitis is slow, and is preceded or accompanied by closure of the abdominal ostium, brought about by coaptation of the walls of the tube and its fimbriæ; or adhesions to the adjoining pelvic peritoneum, ovary, or other structures.

Later on, the uterine end of the tube also becomes closed by exudate; the pus accumulates in the tube and distends its walls, the tumor sometimes being very large. Such a tube is termed a *pyosalpinx.* Unless rupture takes place, these processes are frequently unaccom-
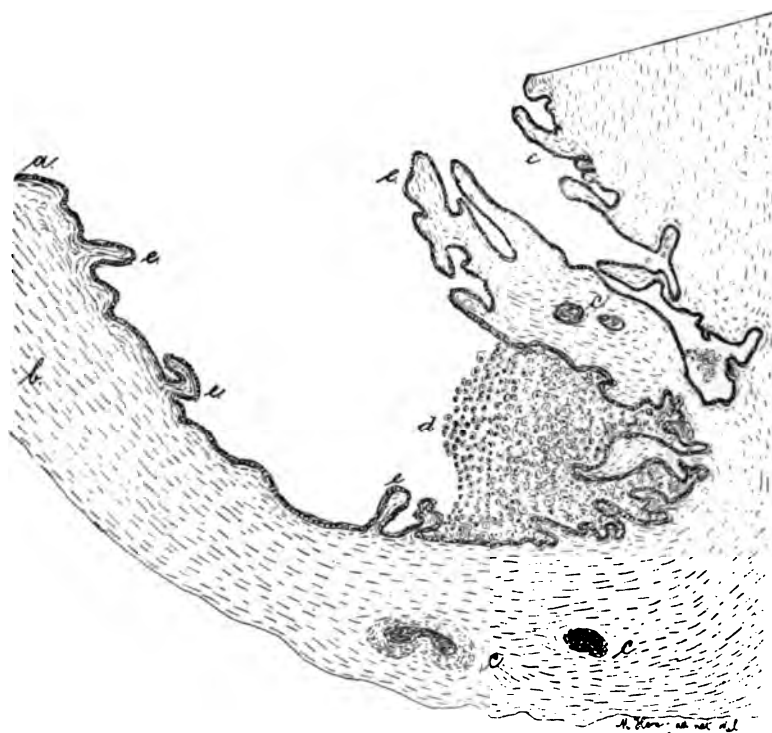
FIG. 349.—Transverse section of Fallopian tube in a case of hematosalpinx, in consequence of torsion, in a patient fourteen years old : *a*, epithelium of tubal mucosæ, very much flattened in consequence of pressure ; *b*, fibrous and muscular wall of tube ; *c*, blood-vessels ; *d*, desquamated epithelium in a condition of hydropic swelling ; *e*, plicæ of tubal mucosæ, most of them almost entirely obliterated in consequence of pressure and stretching.

panied by acute symptoms. Slight rupture of the tubal wall, by a slow process of maceration, and leakage of its contents very frequently occur, each rupture being attended by a sharp attack of pelvic peritonitis. Occasionally, a large leak occurs in the tube-wall, which may result in general diffuse peritonitis, with early death.

The ordinary so-called catarrhal endometritis is commonly followed by hyperplasia and sclerosis of the body of the uterus. This process may extend to the tubal wall, where, by proliferation of connective-tissue cells, it produces the thickened, hard, hyperplastic tube with small lumen. This condition is accompanied by pelvic pain, and often causes

excruciating dysmenorrhea.   The same form of catarrhal endometritis, without hyperplasia, may extend to the Fallopian tubes, producing a mild endosalpingitis, with effusion.   In such cases, when the extremities of the tube become occluded and accumulation of serous fluid takes place, it is termed *hydrosalpinx* or *sactosalpinx* (Fig. 348), the fluid frequently distending the tube to such an extent as to form tumors which may extend half-way to the umbilicus.   When hemorrhage occurs in such a sac, the tumor is called a hematosalpinx (Fig. 349).

Treatment.—In general terms, certain cure of salpingitis of any variety can be secured only by complete removal of the affected tube. Resection of a portion of the Fallopian tube is frequently followed by disappointment.   In some light forms of cystic disease of the tube a portion may be resected, and after the canal has been split open a new ostium abdominale may be constructed and lightly stitched to the surface of the ovary.   Cases amenable to such treatment are few, and secondary operations are frequently necessary.

Though the pus found in chronic pyosalpinx is usually sterile, there is no certain method of determining the fact during the operation, and precautions to prevent contamination must always be enforced.

DISEASES OF THE OVARY.

Neoplasms.—Many changes in the ovary which fall within the domain of normal physiological processes are nevertheless of a quasi-pathological character.   It is now admitted that atrophy of the primary immature follicles begins soon after birth; but other changes in the ovary occur regularly at certain periods.   From the period of puberty or ovulation, changes take place which include rupture of ovarian tissue, formation of a coagulum, proliferation of lutein-cells, and the formation of a cicatrix (corpus albicans).

Under these circumstances, it is not strange that processes which naturally possess inherent pathological features should overstep the physiological limit and lead to true pathological conditions.   It is to be expected that the extensive formative processes which go on in the ovary during the period of sexual activity should frequently lead to the production of neoplasms; and, in fact, all kinds of new growths arise from the ovarian tissues.

For purposes of practical classification, ovarian neoplasms may be divided into epithelial and connective-tissue tumors.   These groups do not include the dermoid cysts, which, by reason of their extensive heterologous character, form a separate class.   It is also necessary, for reasons which will be given later, to group separately the corpus-luteum cysts.

As little is known about the etiology of ovarian tumors as is known about tumors in other parts of the body.

Tumors of the ovary occur at all ages; cystomata are found throughout life from infancy to advanced age; sarcomata are most frequently found in infancy and adolescence; while carcinomata usually belong to more advanced age.

Connective-tissue Tumors.—Pure fibromata of the ovary are very

rare, as a rule are small, and are therefore not of very great surgical importance. Some pathologists claim that small fibromata develop from corpora lutea.

Myofibromata, although rare, are more frequently observed than pure fibromata. As a rule, the fibrous tissue greatly preponderates over the non-striped muscle-fibers; so that a myofibroma or fibromyoma of the ovary is much more sparsely provided with muscle-cells than a similar tumor of the uterus. Occasionally this variety of tumor attains large dimensions (Figs. 350–352).

Calcareous deposits are sometimes found in fibromata and myofibromata of the ovary. It has been claimed that true ossification has

FIG. 350.—Myoma of the ovary; actual size = 25 × 21.5 × 17 cm. (9.8 × 8.5 × 6.7 inches).

been met with; but this is probably incorrect, such cases being dermoid in character.

Sarcomata of the ovary (Fig. 353) are not very common, as compared with cystic tumors, but are more common than fibromata or myofibromata. Sarcomata of the ovary are liable to recur after removal, and have a tendency to form early metastases. They vary

FIG. 351.—Myoma of the ovary; transverse section.

greatly in malignancy, according to their type; and statistics show that a fair proportion of permanent recoveries follow their removal.

It should be mentioned, however, that the correct histological diagnosis of tumors of the ovary is not infrequently quite difficult, and is sometimes impossible; and it may happen that tumors diagnosed
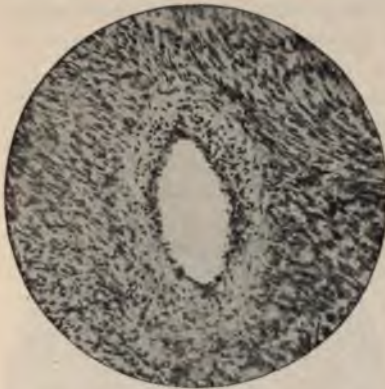
FIG. 352.—Fibromyoma ovarii (Leitz; pant-achr. 3 mm.; eye-piece No, 3).
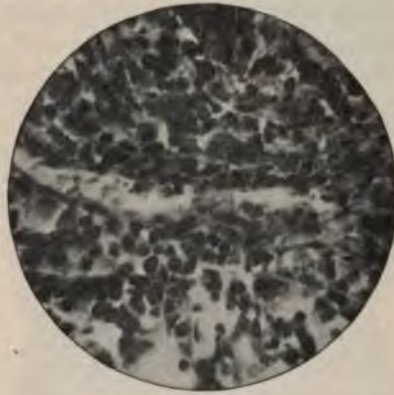
FIG. 353.—Large round-cell sarcoma of the ovary ($\times$ 300).

as sarcomata are in reality benign growths. Such mistakes, of course, materially affect the correctness of the percentage of complete recoveries following the removal of sarcomata of the ovary.

FIG. 354.—Endothelioma of the ovary (two-thirds size), showing part of the Fallopian tube with fimbriated extremity, a stalked hydatid of Morgagni, and the tumor.

Ascites is frequently found in sarcoma of the ovary. The tumor may be encapsulated and without adhesions. Sometimes sarcomata may extend into the neighboring organs, such as the uterus, and may become attached to the wall of the pelvis.

There are many varieties of sarcomata of the ovary, as far as histological findings are concerned. Pure large and small round-cell and spindle-cell sarcomata are met with, as well as those which take their origin from the vascular endothelium, and give rise to neoplasms which have been variously classified. This latter class of tumors histologically resembles carcinomata; but modern pathologists have classified them as *endotheliomata* (Figs. 354, 355).

Sarcomata are also found in which the fibrous element predominates. These are known as *fibrosarcomata* (Fig. 356).

Epithelial Neoplasms.—Carcinomata of the ovary are either solid or cystic. They are usually more or less round or oval, and do not

FIG. 355.—Endothelioma of the ovary (× 180).

FIG. 356.—Fibrosarcoma of the ovary (× 165).

attain a very large size. The soft carcinomata (the medullary form) are more frequently met with than the scirrhous type. The former
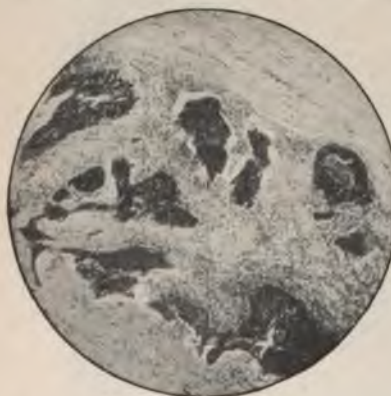
FIG. 357.—Carcinomatous focus in the wall of a simple cyst of the ovary (× 65).
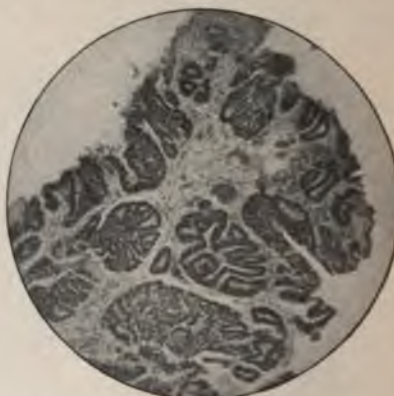
FIG. 358.—Adenoma malignum in the wall of a multilocular cyst of the ovary (× 65).

frequently show secondary degenerative, fatty, or caseous changes, with hemorrhages into the tumor-tissue. True colloid tumors of the

ovary are very rare. In the scirrhous carcinomata the connective-tissue stroma containing the epithelial nests is, as a rule, developed very abundantly, so that the tumors are often as hard as fibromata. Some authors believe that the cysts found in cystic carcinomata form independent of and previous to the carcinoma proper. This view is prob-

FIG. 359.—Papillæ from a cystadenoma papilliferum ovarii (× 300).

FIG. 360.—Cystadenoma papilliferum ovarii (× 65).

ably correct, as without doubt primarily benign cystic tumors of the ovary may secondarily become carcinomatous (Figs. 357, 358). This fact explains the observation that carcinomata occur after ovariotomy for the removal of cystic tumors in the stump. Of course, carcinoma

FIG. 361.—Papilliferous cyst of ovary, showing two small cysts (Leitz pantachr. 7 mm.; eye-piece No. 3).
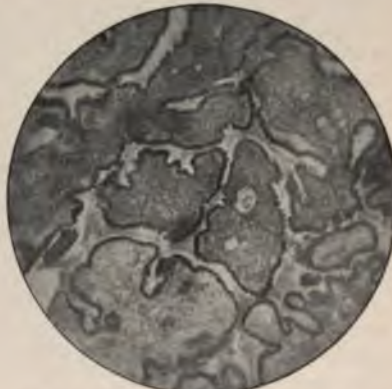
FIG. 362.—Papilloma ovarii (Leitz obj. No. 3; oc. No. 3).

may occur *de novo* in ovariotomy stumps after the removal of a cystic tumor; but, as a rule, the carcinoma proper has already been established, and has been overlooked, because a thorough histological examination of the growth removed has not been made.

Carcinoma of the ovary is often bilateral, but does not always affect

both ovaries simultaneously. It often appears in early life, sometimes even in children. In advanced age it is, as a rule, of the scirrhous type.

Cystic tumors of the ovary are by far the most frequently met with. They are known under the names of cystoma of the ovary, colloid cystoma, cystadenoma, and multilocular or unilocular colloid cysts of the ovary. These tumors arise either from tubular ingrowths of the germinal epithelium of the ovary or from Graafian follicles.

Cystic tumors may be either simple or papilliferous. In the former class, the inner surface of the cyst-wall is smooth; in the latter, it is covered by more or less complicated papillæ or pseudopapillæ, the latter consisting in reality of folds and ridges (Fig. 359).

Multilocular cystic tumors of the ovary are generally made up of several larger cysts, the walls of which contain a large number of small cysts. A cystoma papilliferum rarely consists of small cysts, but presents a honeycombed arrangement (Figs. 360, 361). The cyst-wall consists of fibrous tissue, lined on the inside with cuboidal or high columnar epithelial cells. The lining membrane may rarely be ciliated; but this is not the rule, as it is in parovarian cysts.

Ovarian cystomata were formerly known as colloid cysts, because it was believed that the cyst-contents were of a colloid nature. They are, however, as a rule, of a mucus-like substance, now known as pseudomucin. The contents of the cyst are, however, sometimes of a true colloid character.

Cystomata of the ovary are, as a rule, not malignant; they do not form metastases, nor do they recur after complete removal. However, the more extensive the proliferation of the internal lining epithelium, the greater is the tendency to malignancy (carcinomatous degeneration). Even when no true malignant character can be established, papilliferous cystomata may form so rapidly that the epithelial papillæ may break through the outer cyst-wall and form cauliflower excrescences and growths (papilloma ovarii, Fig. 362). Detached epithelial cells of rapidly growing papillæ may also become implanted upon neighboring organs and structures, such as the peritoneum, and give rise to independent daughter-neoplasms, without, however, acquiring the features of true malignancy.

Dermoids of the Ovary.—Dermoid cysts of the ovary (see Plates 6 and 7) are more or less round in outline, have a smooth surface, and vary in size from 1 to 20 or more centimeters in diameter. They may obliterate the whole ovary, so that only traces of the latter remain in the form of patches or nodules on the surface of the cyst; or they may arise by a pedicle from a relatively well-preserved ovary. At the body-temperature dermoids, on palpation, simulate cysts, unless they contain much bony material, when they are more hard and solid. After removal, if they are kept at a lower temperature than that of the body, they convey a doughy sensation to the touch, dependent upon the fact that the fat which they contain, mixed with other elements, has solidified. The cyst contains, in addition to fat, desquamated epithelial cells, cell-fragments, granules, and cholesterin-crystals. The mass almost invariably contains reddish, blonde, or darker hair, bones, and teeth. Sometimes globular masses the size of a cherry or larger, con-

PLATE 6.

Medium-sized dermoid cyst, open, showing long brownish hair, and a portion of superior
maxilla containing teeth.

PLATE 7.
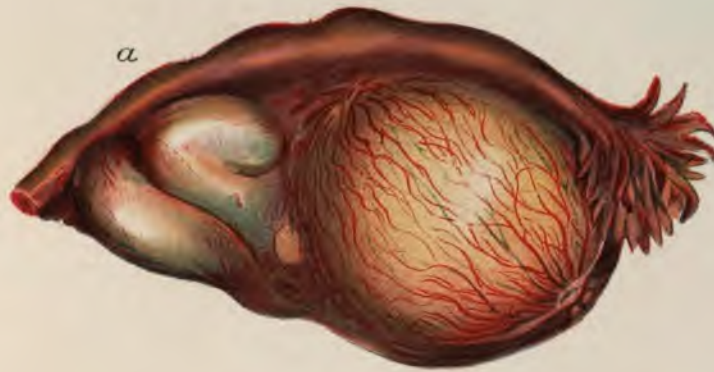
Small dermoid cyst: *a*, cyst with tube and ovary; *b*, cyst opened, showing short
black hair.

sisting of fat-crystals with a nucleus of cholesterin or hair, or both, are found.

Not infrequently dermoids form a part of an ordinary unilocular or multilocular cyst, being found inside of these neoplasms. When such dermoids have caused rupture of the partition-walls of a multilocular cyst, fatty and other matter, hair, etc. may be found scattered throughout the mass. The bones found in dermoids are, as a rule, more or less perfect superior and inferior maxillæ; but other bones, as ribs, phalanges, and bones of the cranium and face, are not infrequently found. The maxillæ are generally provided with teeth, as many as 300 having been observed in one case. Structures of the central and peripheral nervous system, thyroid and salivary glands, mamma, and choroidea and other structures of the eye are also occasionally present.

FIG. 363.—Wall of a dermoid cyst of the ovary, transverse section: *a*, stratified squamous epithelium; *b*, desquamated epithelium; *c*, sebaceous gland; *d*, hair, cut obliquely.

The cyst-wall (Fig. 363) is made up externally of layers of fibrous tissue, which sometimes contain remnants of ovarian tissue, primordial follicles, corpora lutea and albicantia, etc. Above this layer is found the corium, and above the corium an epidermis. The dermoid cyst-wall contains numerous and large sebaceous glands, hair-bulbs and hairs, and usually sweat-gland coils.

The tissue-elements found in dermoids of the ovary generally present all the primary embryonic layers.

Teratomata of the ovary are rare, malignant in character, and are distinguished from ordinary dermoid cysts by the following features:

They are usually larger than dermoids; not cystic, although they ordinarily contain a large number of small filled cysts. On section, a teratoma is seen to be divided by connective-tissue septa into many small compartments. These compartments contain mucoid, colloid, and other hyaline material, bone, teeth, hair, pigment, cartilage, muscular fibers, etc. These elements are distributed in an absolutely lawless manner; and it is impossible to trace them with reference to their position and their mutual relations to the primary embryonic layers. The derivatives of these three layers have apparently been scattered at a very early period, in consequence of totally atypical processes of proliferation.

In addition to more or less normal tissues, distinctly pathological tissue-elements are found, such as myxosarcomatous tissue, irregularly proliferating epithelial masses, epithelial pearls, etc. Teratomata may be differentiated anatomically from ordinary dermoid cysts by their atypical character.

Teratomata may be looked upon as dermoids which, early in their course, have become malignant, and which display all the features of malignant neoplasms, such as the formation of true metastases, tendency to recurrence after removal, cachexia, etc.
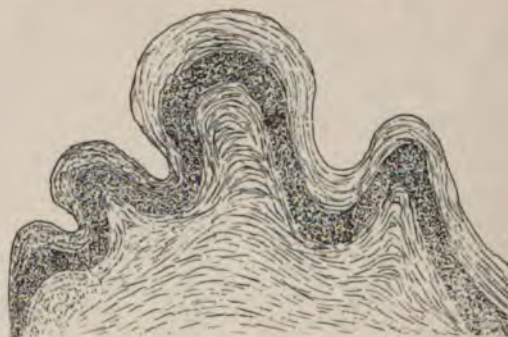
FIG. 364.—Calcareous degeneration of a cyst of the corpus luteum; transverse section of cyst-wall, decalcified. The site of the most dense infiltration with lime salts is indicated by dots (slightly magnified).

Of the histogenesis of dermoid cysts of the ovary, very little is as yet positively known. Two views are generally held regarding their origin. According to the first, they originate from embryonic intrusion into the ovary. The adherents of the second hypothesis claim that these neoplasms arise exclusively from the ovum, which, under some unknown stimulus, begins to develop in a necessarily unsuccessful attempt at parthenogenesis.

Corpus-luteum Cysts or Tumors.—The corpus luteum of the ovary not infrequently gives rise to the formation of cysts. In the large cysts, the wall contains such an extensive layer of lutein-cells that it cannot but be looked upon as a neoplasm. Small corpus-luteum cysts are not at all rare. They are frequently found in women of advanced years who suffer from dysmenorrhea dependent upon an enlarged hard uterus the seat of a hyperplastic metritis. Cysts up to the size of the fist are not very common, but the writer has seen at least 2 cases of this kind.

The formation of corpus-luteum cysts appears to be dependent upon an oöphoritis or conditions which lead to more or less chronic passive congestion of the ovary. Under such conditions, hemorrhage into the ruptured follicle is probably not infrequently much more extensive than ordinary, and the lutein-cells are not equal to the task of forming a normal corpus albicans.

Corpus-luteum cysts contain a more or less thick, dark fluid.

A few cases of calcification of corpus-luteum cysts are on record. The writer recently operated upon a very characteristic case of this kind. It will be seen from the illustration that the roundish mass presents a very uneven surface, resembling in configuration the convolutions of a small brain. This mass, when transversely cut, was seen to enclose a cavity (Fig. 364). Microscopical examination of the partially decalcified wall showed that its matrix consisted of hyaline fibrous tissue exceedingly poor in nuclei. The zone of denser calcareous infiltration appeared to be that formerly occupied by lutein-cells; but recognizable remnants of these could not be found. The soft tissue removed with
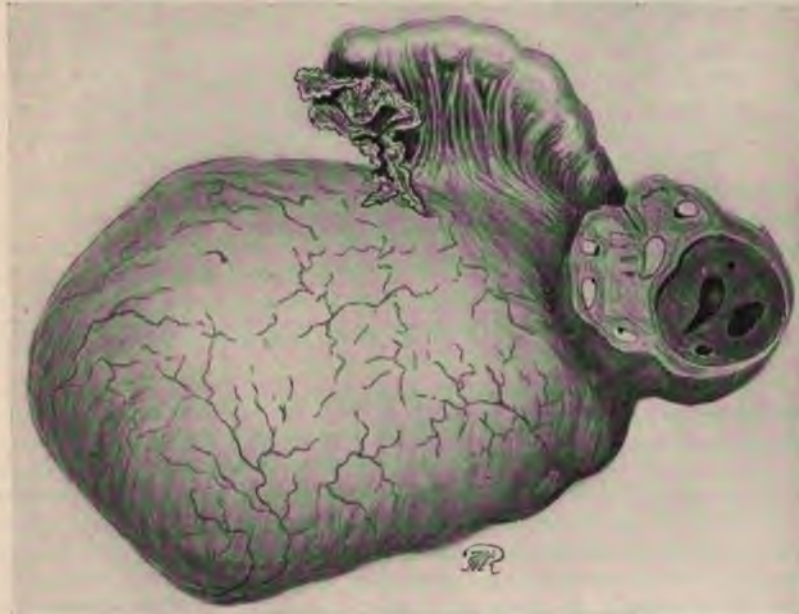
FIG. 365.—Small parovarian cyst and cyst of the corpus luteum.

the calcareous mass contained remnants of ovarian tissue, evidently in a state of very advanced chronic inflammation.

Parovarian Tumors.—Between the folds of the mesosalpinx lies the epoöphoron, which consists of a longitudinal main canal (Gärtner's duct) and twelve or more transverse perpendicular smaller ducts emptying into the main canal, some of which occasionally penetrate the substance of the ovary. On the inner, or uterine, side of this structure small yellowish conglomerations are found, which consist of remnants of tortuous canaliculi and sometimes glomeruli. This latter

structure is called the paroöphoron. Both the epoöphoron and par-oöphoron are remnants of the Wolffian body, and frequently develop into cystic tumors. Whether these tumors are true neoplasms or merely retention-cysts is not yet decided.

The tumors arising from these structures have been divided into epoöphoronic and paroöphoronic tumors. This classification is incorrect, because of the impossibility of invariably tracing the exact origin of the cyst, and because the differentiation possesses little or no clinical or pathological importance. For this reason, all these tumors are classed as parovarian.

Tumors of the parovarian structures are almost exclusively cystic.
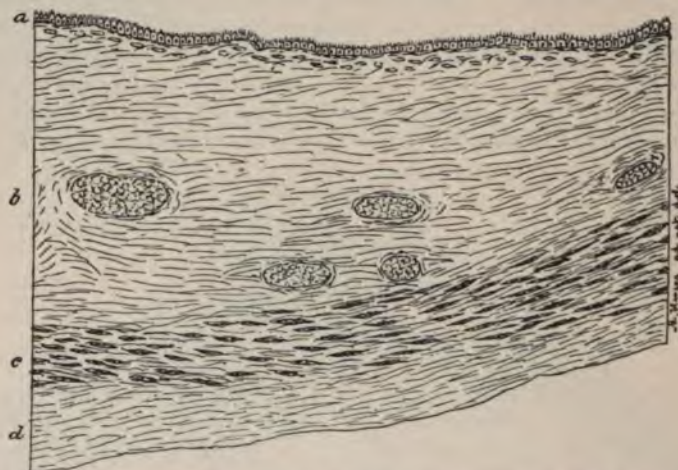
FIG. 366.—Wall of parovarian cyst (× 85): *a*, ciliated epithelium lining cyst-wall interiorly; *b*, connective tissue (5 veins t. s.); *c*, involuntary muscle-fibers; *d*, fibrous connective tissue.

Small parovarian cysts are very frequently seen in the course of operations for other conditions, while very large cysts are quite rare.

Cystic tumors of this class are absolutely benign; they do not recur after removal, nor do they form metastases. They are surrounded everywhere by peritoneum derived from the broad ligament. They therefore have, as it were, a double wall. The outer or peritoneal wall is usually freely movable over the cyst-wall proper (Fig. 366). The latter is composed of structures derived from the tubules from which the neoplasm takes its origin. The freely movable peritoneum forms a

FIG. 367.— Epithelium in Fig. 366, more highly magnified (× 375).

valuable feature in the differential diagnosis between ovarian and parovarian cysts. Other distinguishing features are that the wall of a parovarian cyst is, as a rule, thin and transparent; the cyst-fluid thin, watery, colorless, of very light specific gravity, and free from mucin and pseudomucin. The latter is almost invariably found in true ovarian cysts. The presence of involuntary muscle-fibers in the walls of parovarian cysts is an important microscopical feature in the

differentiation between cysts of this variety and ovarian cysts. In a number of the writer's cases which showed macroscopically all the characteristic features of parovarian cysts, muscle-fibers were always found. The epithelium lining the interior of a parovarian cyst is almost always ciliated.

Kossman believes that parovarian cysts arise, as a rule, from small accessory fimbriated extremities or from small accessory tubes springing from the fimbriated extremity. While this view has not received extensive support from authorities on the subject, the writer has operated upon at least one case of parovarian cyst in which it appeared that the origin of the cyst was an accessory Fallopian tube arising from the anterior wall of the fimbriated extremity. These small accessory tubes, which are generally closed at their sessile end, may also be occluded at their free extremity, become cystic, and form cysts which resemble and would be classified as parovarian cysts.

Parovarian cysts are usually unilocular; they may rarely be multilocular, but in such cases the number of sister- or daughter-cysts is limited. As a rule, parovarian cysts are small, although cysts weighing 40 pounds or more have been reported.

Whenever parovarian tumors attain a large size, they displace and change the shape and configuration of the tubes and ovaries. The tube is usually lengthened and curves around the cyst, and the fimbriated extremity is pulled away from the ovary. The ovary is also displaced and more or less flattened.

As the small perpendicular duct of the epoöphoron sometimes penetrates through the hilum into the substance of the ovary, we may meet parovarian cysts in a locality in which even microscopical examination might leave some doubt as to their real character. In such cases the cyst-wall might contain ovarian tissue; and this would be misleading, unless the wall were examined carefully in a number of places.

Neoplasms other than cysts, such as carcinomata, adenosarcomata, fibro-adenomata, and fibrosarcomata, have been reported as arising from the parovarian structures. These are so rare, however, that they deserve only a passing notice.

Symptomatology.—The symptoms of ovarian tumor may be considered under three heads: Those due to disturbances of function; those due to inflammatory changes; and those due to mechanical disturbances.

Functional disturbances, such as menorrhagia, dysmenorrhea, and other irregularities of menstruation, are common.

Inflammatory changes bring about adhesions to the adjoining organs. During the formation of these adhesions, the usual signs of circumscribed peritonitis; namely, pain, fever, etc., are present.

Mechanical disturbances are due to traction from adhesions or pressure from the size or location of the growth.

Adhesions to the intestines may produce colic or any degree of obstruction. Adhesions to the uterus or tubes may result in distortion and malposition of these organs. When the bladder is involved, urinary disturbance usually follows. When a tumor attains a sufficient size, pressure upon neighboring organs may produce a variety of

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symptoms. Pressure on the intestines will produce varying degrees of painful obstruction; pressure on the uterus, hydronephrosis; pressure on the bladder, vesical irritation; pressure on the nerve-trunks, pain; and pressure on the vessels, edema and varicose conditions. Extremely large tumors may produce so great distention of the abdomen as seriously to interfere with respiration and general circulation. A tumor of the ovary may become impacted in the pelvis, and under these circumstances the symptoms of pressure and obstruction are intensified.

Sooner or later the general health becomes affected, and, in case of large cysts, emaciation, especially in the upper half of the body, is almost constant.

•The nature of the growth has much to do with the intensity and the type of symptoms; malignant neoplasms affect the general health earlier than benign growths, and are usually accompanied by ascites.

In benign neoplasms, such as small fibromata, small follicular or corpus-luteum cysts, which do not attain large dimensions and do not form adhesions, the disease may exist for an indefinite period without giving rise to active symptoms.

The **diagnosis** is based upon the results of the physical examination. Smaller growths are palpable by bimanual examination only. They are felt as more or less globular masses in the region of the ovary, and are movable unless fixed by adhesions. This mobility is distinct from that of the uterus. It is frequently difficult to distinguish ovarian tumors from tubal enlargements unless the tube can be palpated separately. The density of the mass may assist in determining its variety.

Small, pedunculated, subserous fibroids of the uterus often resemble small ovarian tumors; but the former can usually be recognized by their firm, thick pedicle. The diagnosis is much more difficult when small ovarian tumors are adherent or impacted. Tumors of medium size rising above the pubes produce prominence and dulness over the hypogastric region; they are, as a rule, easily palpable, and their density easily determined. Bimanual, vaginal, and rectal examinations will frequently determine their origin. Usually the cyst-wall can be plainly felt, and the presence or absence of fluctuation ascertained. When the origin is determined, the prominence of such tumors, and the dull percussion, surrounded by a well-marked zone of resonance, generally make the condition unmistakable.

The great majority of very large tumors are cystic, and fluctuation in the whole or a part of the mass can often be recognized. Tympanites is generally evident at the epigastrium or about the lumbar region. Distention of the colon with air may assist in the diagnosis. The diagnosis may be obscured by ascites, although the presence of this condition does not exclude ovarian tumor. Advanced ectopic gestation with a dead fetus may closely simulate a large multilocular tumor.

The *differential diagnosis* of the varieties of ovarian tumor is possible only under favorable conditions. Fluctuation indicates cystic tumors; solid consistency points to fibroma, sarcoma, endothelioma,

carcinoma, or teratoma.   Fibroma, myoma, and fibrosarcoma are denser than pure sarcoma or endothelioma.   Carcinoma is almost always bilateral and unevenly nodular.   Although ascites is usually present with malignant tumors, this sign is not pathognomonic, because when papillæ perforate the wall of a cystic tumor, ascites usually ensues.   This condition is known as *papilloma of the ovary*.   Dermoids can frequently be recognized by their doughy consistency, and by hard, sharp borders and points when they contain bones.

Prognosis and Treatment.—Simple cysts (hydrops folliculi, Fig. 368), fibromata, myomata, dermoids, and corpus-luteum cysts of small size and uncomplicated are not in themselves dangerous. Cystomata papillifera and parovarian cysts, because of their progressive growth and the complications to which they give rise, usually destroy life unless removed.   Successful removal, together with the extirpation of the corresponding ovary, means permanent cure; although, of course, similar disease may arise in the other ovary.   Sarcomata and endotheliomata are malignant growths; but recent statistics appear to show that early removal is followed by a reasonable percentage (30 per cent. to 35 per cent.) of permanent cures.   Carcinomata and

FIG. 368.—Over-mature Graafian follicle deep down in the ovary; hydrops folliculi (× 85).

teratomata are extremely malignant; and in spite of complete and early removal, which is our only resource, the prognosis is very unfavorable.

Generally speaking, the proper treatment for all tumors of the ovary is removal as soon as they are discovered, even if they have given rise to no symptoms.   Although the simple forms first mentioned are not dangerous, the uncertainty of diagnosis makes removal the best course to pursue, as the risk of delay is greater than that of modern operation.   Small benign tumors frequently grow rapidly, and apparently benign tumors may in reality be malignant.

Ovarian tumors are especially prone to dangerous accidents, probably because of their mobility.   The most common accidents are rupture, suppuration, and torsion of the pedicle, all of which may give rise to severe and even fatal peritonitis.   There are few ovarian tumors, even if small and benign, that do not give rise to menstrual disorders which cannot be cured until the tumors have been removed. Hydrops folliculi frequently affects both ovaries.   When this condition occurs in young women, resection of the prominent cysts, leaving a portion of the healthy ovary, may be all that is necessary.   Small fibromata and myomata can also be cured by resection of the tumor without removal of the entire ovary.   Cystomata papillifera, dermoids, and parovarian cysts, as a rule, demand complete removal of the affected ovary.   Sarcomata and endotheliomata can sometimes be per-

manently cured by complete exsection of the ovary and tube well into the cornu of the uterus. If in these cases there is the least appearance of infiltration in close proximity to the uterus, the opposite appendages and the uterus would better be removed also. In carcinomata and teratomata radical operation is imperatively demanded.

Infectious Diseases of the Ovary (*Ovaritis or Oöphoritis; Peri-ovaritis; Ovarian Abscess; Sclerosis or Cirrhosis of the Ovary*).— Septic diseases of the ovary are not well understood. The text-books usually describe congestion of the ovary, several varieties of acute and chronic ovaritis, and peri-ovaritis. Virulent micro-organisms undoubtedly penetrate into and infect the ovary. These infective processes produce great changes in both the follicular and the connective-tissue elements. Sometimes coalescence and alteration of the Graafian follicles with hemorrhage occur; sometimes proliferation of connective-tissue elements with hypertrophy is observed; at other times the outer portions of the ovary are most affected, and necrotic changes occur, or a cirrhotic condition with atrophy or suppuration results, which is then usually due to streptococcus-invasion.

One of the difficulties in the proper comprehension of this subject lies in the fact that when ovaritis exists, it is usually only part of a complex condition which involves the tube and uterus, and is generally secondary. When the lymphatics are the channels of invasion, ovarian abscess frequently ensues; and this may remain for a considerable time the only recognizable evidence of extra-uterine disease. This fact has been fully established by recent operative observation. Some authors go so far as to claim that the ovaries have distinct lymph-channels communicating directly with the cervix and cervical canal. Be this as it may, the fact has certainly been established by observation that ovarian abscess frequently follows miscarriage, and is then due to unclean manipulation of the cervical canal. In such cases evacuation of the contents of the uterus, with removal of the ovary or ovaries, is followed by complete cure, the Fallopian tubes having apparently never been affected. Streptococci are almost always found in such ovarian abscesses when operation is made during the acute stage.

Ovarian abscess associated with pyosalpinx probably always owes its origin to contiguity. Ovarian abscess of the lymphatic variety affects the adjoining peritoneum at its very outset, and after a few weeks a general pelvic peritoneal involvement may ensue, which in time extends to the opposite side of the pelvis. Ovarian abscess may exist for years, however, without producing suppuration at any point beyond; although the complicating pelvic peritonitis, by reason of its multiple adhesions, produces the most complex forms of pelvic disease. The original abscess may attain large dimensions; if not well protected by peritoneal adhesions, it may rupture and produce general septic peritonitis or a most aggravated form of general pelvic disease. The lymphatic ovarian abscess, like all streptococcus-infections, is almost always an acute disease, with sudden onset and febrile symptoms.

It is doubtful whether any form of septic ovaritis ever results in

spontaneous cure by absorption, although in a reasonable proportion of cases the abscesses are emptied spontaneously by a safe route and the patient recovers. In other varieties of ovaritis no acute symptoms may occur, and eventually the ovaries may share in the general atrophy incident to the menopause, giving no trouble thereafter.

Treatment.—The cure of non-suppurative ovaritis which gives rise to sufficiently acute symptoms to demand operative interference consists in removal of the affected organ. This is most properly and conveniently done through an abdominal incision. When portions of the ovary appear to be healthy, it may be advisable to resect only the diseased portion of the organ. This conservative operation requires an experienced operator, as otherwise the remaining portion of the ovary may give rise to much trouble after a few months.

The suppurating ovary which accompanies pyosalpinx should be removed by abdominal section with the affected tube. Occasionally both tube and ovary are merged into a large abscess. This can frequently be reached and drained through a vaginal incision with practically no danger. Permanent cure may result; although in some cases a radical operation may be demanded later on. The operation is then relatively safe because of the diminished bulk of the abscess-mass and the lessened amount of pus.

Incision with drainage through the posterior vaginal fornix is the treatment for acute recent abscess of the ovary when there is no apparent involvement beyond the adjoining pelvic peritoneum. This operation is practicable in 90 per cent. of the cases. The ovary need not be removed. It is incised after the cavity is opened, and drained by gauze. This is the ideal treatment, and will permanently cure 14 out of 15 cases, with practically no risk.

Bilateral Septic Affections.—When severe septic pelvic disease affects the adnexæ on both sides, the treatment demands special consideration. The question of removal of the uterus, when it shows no special signs of disease, has been vigorously discussed. In young women, when there is the least hope of saving even a part of one ovary, the abdomen should be opened and the diseased portions removed. Infiltrated and thickened Fallopian tubes with closed abdominal ostia should be entirely resected well into the cornua of the uterus. When, in the course of these operations, both ovaries are found to be entirely diseased, they should be removed, together with the uterus and Fallopian tubes. The cervix should be left if it is apparently healthy. In women approaching or past the menopause, it is frequently advisable to remove the uterus and appendages by the vaginal route, as this operation produces less shock, does away with the abdominal scar and the dangers of subsequent hernia, and is less dangerous than the abdominal operation.

Ovariotomy; Salpingectomy; Tubal and Ovarian Resection.—The majority of tumors of the ovary and Fallopian tube are more perfectly and safely removed through an abdominal incision. In rare cases, their removal by the vagina may be indicated. A small ovarian tumor which is movable and lodged in the cul-de-sac of Douglas may be coaxed through a small, posterior vaginal incision, removed with the greatest ease, and its pedicle ligated. The results of this

operation will prove ideal. Its value is especially apparent when the patient is over sixty years of age and has a very thick abdominal wall. This operation can occasionally be performed with advantage through an anterior vaginal incision after separating the bladder from the uterus.

The technic of abdominal section, as described in Chapter VIII., is to be followed. After the abdomen has been opened, the course to be pursued depends upon the conditions then found to exist.

Septic Cases.—In septic cases the first and most important step is to wall off the infected pelvic area from the unaffected portion of the abdominal cavity by numerous well-wrung gauze pads. Separation of omental adhesions must always begin from the most inferior point. In dealing with a large suppurating focus, in which the surface of the mass is exposed, it may be better to empty the cavity as far as possible by a large aspirator, or to evacuate the purulent contents through a small incision, receiving it on sponges, before complete isolation of the mass is attempted. If intestinal adhesions are present, they can now be gradually separated, after which, if the mass is adherent to the pelvic wall, the separation of these adhesions may be completed.

The peritoneal covering of abscess-cavities is frequently much thickened, and in such cases an incision through this structure down to the abscess-wall proper may greatly facilitate enucleation. In this part of the work the success of the operator depends greatly upon his tactile ability to follow natural lines of cleavage. When one side has been liberated, it is better immediately to investigate the condition of the opposite tube and ovary, in order to determine upon the general plan of operation and to fix in mind exactly what is necessary to be done. If only one appendage needs removal, it can then be done. Complete removal of the tube well into the cornu of the uterus is advisable when any portion of that tube is affected.

Even in septic cases, healthy portions of ovaries may be saved, particularly in women of childbearing age.

If both ovaries are completely destroyed, it is better to remove the uterus, also. Perforation of the broad ligament and ligation *en masse* are often impracticable, and are not safe.

Catgut is the preferable material for the control of hemorrhage and for covering raw surfaces. The first ligature would better be applied at the outer extremity, encircling the upper border of the infundibulo-pelvic ligament. Even though a little more blood is lost, it is better to proceed from the outside toward the uterus and remove the whole tube and abscess-sac, putting on forceps for temporary hemostasis. The exsection, which is best done with scissors, is completed by removing a wedge-shaped piece from the cornu of the uterus. A continuous catgut suture may now be applied to bring together the cut edges of the broad ligament along the line of incision. When the edge of the uterus is reached, this continuous suture is tied, and two or more interrupted sutures applied to coapt the edges of the uterine wound. All hemorrhages must be controlled by ligatures. It is never necessary, but is, on the contrary, dangerous to employ catgut of large size. Finally, all the raw surfaces must be covered by the neighboring peritoneum, and in this work only the finest of catgut should be used.

Pelvic Cellulitis.—This term is applied to that form of disease in which the cellular tissue around the uterus has become infected by way of the lymphatics.

Septic pelvic disease may be limited to the cellular tissue which surrounds the uterus. Infection occurs through the lymphatics, and is usually of puerperal origin. It may produce a phlegmon behind the uterus, between the folds of the so-called sacro-uterine ligaments, or between the folds of the broad ligament on either side. More rarely it affects the vesico-uterine space or the cellular tissue surrounding the round ligaments. It is seen also as a complication of the other forms of septic pelvic disease heretofore described, either preceding or occurring simultaneously with them.

Like other septic conditions of lymphatic origin, its onset is usually sudden and acute, and is frequently accompanied by very high fever. It is recognized by the early appearance of thickening and enlargement both at the sides and back of the uterus. Suppuration occurs in only a small proportion of the cases; a large number of patients recover by absorption, with little or no damage, and may bear children later. In some cases the adjoining peritoneum becomes involved and adhesions follow, which produce various distortions of the affected parts. When suppuration occurs, the abscess may rupture through the vagina or rectum, or externally just above Poupart's ligament; or it may push back the peritoneum and involve the whole iliac fossa on the affected side.

Treatment.—When the diagnosis is clear and there is no suppuration, operative treatment is not required. It is rather difficult, however, to differentiate pelvic cellulitis from the various forms of peritonitis. Obliteration of one or more of the vaginal fornices, with apparent shortening of the cervix and absence of a diseased ovary or tube in a puerperal patient, usually makes the diagnosis possible. When pus is suspected, early evacuation is advisable. This can almost always be most safely accomplished by vaginal or inguinal incision.

Pelvic Peritonitis.—This term is commonly applied to various forms of localized pelvic inflammation which cannot be differentially diagnosed. Primary uncomplicated pelvic peritonitis probably does not occur. Occasionally, however, the primary disease escapes detection, and serous or seropurulent fluid accumulates in the cul-de-sac of Douglas; and in this case a vaginal incision behind the cervix, with drainage, is followed by disappearance of the frequently serious symptoms, and complete cure of the patient. On the other hand, the primary disease may gradually disappear, and after long illness the peritoneal adhesions remain as the only well-marked evidences of disease. This form of chronic pelvic peritonitis frequently causes disturbance of physiological function by compression and distortion of the tubes, ovaries, uterus, bladder, or ureters, and may require surgical interference. In such cases occurring in young women the abdominal incision is preferable, because conservative operation is frequently possible, and is better accomplished by this route. In women near or past the menopause, vaginal hysterectomy may be more easily and safely performed.

CHAPTER XXII.

GYNECOLOGY (Continued).

DISORDERS OF MENSTRUATION.

ALTHOUGH all forms of pelvic disease may give rise to disorders of menstruation, it frequently happens that women become great sufferers without any apparent structural change in the genitalia. Amenorrhea, or absence of menstruation, menorrhagia, or excessive menstruation, and dysmenorrhea, or painful menstruation, may all exist without apparent cause, or may be associated with malpositions of the uterus without appreciable lesion.

Amenorrhea may be dependent upon defective—so-called infantile —development, or may follow exposure during menstruation or change of climate. Massage, stimulation of the general development of the patient, and, finally, the local use of electricity are the only means that can be recommended for this condition ; and the results are very uncertain.

Menorrhagia without apparent cause may often be treated empirically by dilatation, curettage, and packing the vagina and even the uterus.

Dysmenorrhea may be treated by dilatation and curettage ; and the uterine canal may be kept patent by the insertion of a glass, light metal, or gutta-percha intra-uterine stem. This latter expedient, however, is attended by considerable risk, and the patient so treated should be kept under constant observation.

Both menorrhagia and dysmenorrhea are frequently associated with malpositions of the uterus, the cure of which is followed by disappearance of the symptoms. Dysmenorrhea, however, is so frequently a local manifestation of neuroses or unappreciable congenital abnormalities that the prognosis should always be guarded.

In the majority of cases, disorders of menstruation exist only as symptoms of special forms of surgical disorders, which are considered under their respective headings, or as expressions of constitutional pathological conditions which call for general medical treatment.

UTERINE DISPLACEMENTS.

The uterus is held in position by an intricate network of structures, of which the various uterine ligaments form a component part, and which is known as the pelvic floor. As the result of congenital anomalies, or by reason of the presence of neoplasms, inflammatory swelling, or cicatricial contraction, the uterus may be distorted and pulled or pushed out of position to any part of, or even beyond, the pelvic cavity. The elementary malpositions, however, which result from a

disturbance of the relation between intra-abdominal pressure and the resistance offered by the natural supports of the uterus are the only ones which should be considered under the head of displacements.

Intra-abdominal pressure may be increased and the natural uterine supports weakened by many causes, chief among which are lacerations and relaxations due to parturition, which result in alterations in the position of the uterus.

The peculiar anatomical attachments of the uterus, and its normal range of mobility, influenced by intra-abdominal pressure and the variable conditions of the bladder and rectum, easily explain how a simple temporary displacement may by frequent recurrence become an habitual malposition giving rise to appreciable symptoms.

Innumerable autopsies have proved that, consistent with perfect health and without appreciable abdominal sepsis, peritoneal surfaces become adherent in the cecal, hepatic, and sigmoid regions—locations which are particularly subject to friction and irritation. In the same manner the uterine peritoneum probably becomes adherent, and irreducible displacements occur without apparent septic complications.

Uterine displacement is frequently associated with various forms of septic disease. Sometimes sepsis causes malposition by the formation of adhesions; at other times the displacement, by interfering with the circulation and proper drainage of the uterus, induces sepsis. Irritative conditions of the bladder and rectum, dysmenorrhea, menorrhagia, sterility, and habitual miscarriage are the most common results of displacement; while pelvic pain or distress, or neuralgia, is seldom absent.

Treatment.—When a displacement is habitual, but not made permanent by adhesions, it may be cured by measures addressed to the correction of the causes which effect deviation in the axis of the force of intra-abdominal pressure. This is best accomplished by training and restraining abdominal pressure above, in order to approximate the normal direction, and by upholding the uterus below, in order that its most favorable surface may be presented. The corset should be loosened, abdominal massage should be practised, together with such physical culture as is calculated to increase abdominal support, and, in addition, a well-fitted abdominal belt may be worn. Pelvic massage also is often successful in restoring the tone of relaxed supports. Operative measures may repair pelvic injuries, and artificial supports, such as tampons and pessaries, may be used to place and retain the uterus in its most advantageous position. The bowels and bladder must, of course, be regulated. These means frequently fail because the supports of the uterus have become altered by inflammatory or atrophic changes.

When a displacement is made permanent by adhesions, operative measures become imperative unless the adhesions are of slight degree. They must be uncovered and separated, and the accompanying septic conditions, which would otherwise renew them, must be removed. It then becomes necessary to imitate nature and hold the uterus permanently in normal position by specially devised operations, which will be described later.

The ordinary forms of displacement are prolapse, anteversion, retro-

version, and lateroversion. The corresponding flexions occur when the uterine body is bent upon itself in excess of the normal degree.

Prolapse of the uterus is a descent of that organ below its normal level. It is, in reality, a hernia or protrusion of the uterus and more or less of the attached pelvic structures into the pelvic outlet, caused by pressure from above, combined with lack of resistance of the pelvic floor, the latter having in most instances been weakened by lacerations and relaxation due to childbirth. Sometimes the whole pelvic floor becomes prolapsed.

Prolapse is clinically described as of three degrees, according to the extent of the descent of the uterus. It is a process that involves the various organs which surround and are attached to the uterus. Clinical experience demonstrates that in prolapsus the anterior vaginal wall first protrudes, and is gradually extruded from below upward. This protrusion of the anterior vaginal wall, which, in the ordinary forms of prolapse, precedes, at least in part, the appearance of the cervix, is called *cystocele*, because the bladder, which is attached to the anterior wall of the vagina, forms part of the protrusion. As the anterior protrusion progresses, the uterus descends and the cervix appears at the vulva; while the posterior vaginal wall doubles upon itself and descends toward the vulvar opening from above downward. Finally, the entire vaginal canal is turned inside out, and the posterior vaginal wall is peeled off from the rectum, with the exception of the very lowest portion, which becomes elongated, the rectum remaining in place.

In a reasonable proportion of cases another mechanism prevails. When a large tear in the perineum has occurred, with retraction of the torn ends of the levator ani muscle, straining (particularly at stool when the patient is constipated) results in the development of a *rectocele*, which is soon followed by a cystocele; and the continuation of these conditions brings about a hernial protrusion which drags the uterus down. When the vaginal and uterine extrusion is complete, the condition is known as *procidentia*.

Non-operative Treatment of Prolapsus.—Massage has been used and lauded by its various exponents. While this treatment may be useful, occasionally it possesses certain disadvantages which will probably result in its disuse. Although massage is especially applicable to recent cases, yet the cure will probably not be permanent, because of the difficulty in removing the cause. Besides this, vaginal massage is distasteful to the majority of women, and is not without danger.

Vaginal supports never succeed well in severe and in old cases. In recent cases, operations which involve no risk are very successful, and delay is therefore not advisable.

Non-operative measures should probably be restricted to those cases in which operative treatment is contra-indicated by reason of extreme age or bad general health, or in which operation is refused or has failed.

Anteversion and Anteflexion.—Plate 8 shows that in its normal position the uterus is both anteverted and anteflexed. The terms anteversion and anteflexion refer simply to an exaggeration of normal conditions. It is often difficult to decide whether an anterior position of the uterus is physiological or pathological.

PLATE 8.

Uterus in normal anteversion; perineal muscles.

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The two most prominent symptoms of pathological anteposition are dysmenorrhea and vesical irritation. These symptoms often form the basis of an opinion; but, as they may be due to other causes, care must be exercised before deciding on active treatment.

In congenital anteversion and anteflexion, the uterus is usually small and undeveloped, with a pinhole os. In acquired anteflexion, the most common cause is shortening and thickening of the uterosacral ligaments, the result of inflammation in the cellular tissues between the folds of these ligaments, which produces a bend at the junction of the body and cervix, and frequently an obstruction of the cervical canal. In these cases thickening behind the uterus is often observed.

Treatment.—Mechanical supports intended to correct anterior displacements are of little value, and are often harmful. Careful dilatation and curetting may relieve the symptoms. An incision in the median line, beginning near the internal os and splitting the posterior lip, with inversion of the edges to avoid reunion, lessens the angle of the cervical canal and frequently relieves the dysmenorrhea.

Retroversion and retroflexion are the most common malpositions of the uterus. Congenital retrodisplacements are rare. The first degree of prolapse leads, as a rule, to retrodeviation; and any agency which weakens uterine support or causes enlargement of the uterus tends to produce this condition. The most common etiological factors are lacerations or excessive relaxation of pelvic supports, from parturition or other cause. The uterus sinks in the pelvis, normal anteversion disappears, intra-abdominal pressure is exerted upon the fundus, and later upon the anterior surface of the uterus, and retroversion or retroflexion is established. When the round ligaments are relaxed and the uterus becomes enlarged from any cause, it frequently falls into retroposition, although the supporting power below may be uniform and perfect. In a considerable proportion of cases the malposition is simply a complication of pre-existing conditions, as, for instance, when the uterus is pushed back by a tumor located anteriorly, or pulled back by posterior adhesions due to disease of the tubes, ovaries, or cellular tissues.

When retroversion or retroflexion resulting from deviation of intra-abdominal pressure, without intra-abdominal sepsis, is first established, the malposition may not be constant; but after frequent repetitions it becomes habitual, and in many cases irreducible, because, as stated above, peritoneal surfaces may become adherent by constant friction without appreciable abdominal sepsis. It is probably a fact that a uterus may be displaced posteriorly by gravity alone; as, for instance, when the posterior wall becomes heavier by reason of inflammatory thickening or a fibroid growth.

Non-operative Treatment of Retrodeviations.—A retroverted or retroflexed uterus may be curable by simple means. It must be borne in mind, however, that relapses are almost certain to occur unless the originating cause is removed. The treatment by massage, tamponade, and pessaries is more successful in this than in any other variety of displacement, and is more successful in versions than in flexions. Slight force applied upward and backward in the anterior fornix and upon the anterior surface of the cervix, or upward and forward in the posterior

vaginal fornix and upon the lower posterior surface of the uterus, will often suffice to restore a retroverted or retroflexed organ into a normal anterior position. Very slight support continued for a few months, together with well-directed treatment of the predisposing condition, will retain it in place. Vaginal tamponade frequently repeated may in itself accomplish very satisfactory results. Massage intelligently applied also gives good results. Non-adherent retroverted uteri may often be kept in position by well-fitted pessaries. Probably not more than 15 per cent. of these cases, however, can be permanently cured without operation.

It is often difficult to determine whether the symptoms which accompany the retrodeviation are due to conditions bringing about the deviation or whether the malposition was the original cause. Endometritis and perimetritis, with discharges, dysmenorrhea, and menorrhagia, are almost constantly present. Pelvic pain, backache, and innumerable nervous disorders are very common. These displacements are frequently the causes of miscarriages, which often become habitual. Constipation and painful defecation, with hemorrhoids or anal fissure, are also frequently observed.

Operative Treatment of Malpositions of the Uterus and Repair of Injuries to the Pelvic Floor.—Operations for Prolapse. —The operative measures for the cure of prolapse contemplate the permanent restoration of the uterus and its natural supports to normal position, either above or below, or both, with the object of regaining normal function. It is evident, therefore, that early operation is much to be desired, as relapses after operation are frequent in old and severe cases.

Plastic operations are performed on the vaginal wall and on the torn or relaxed muscles and fasciæ extending down to and including the vulva and perineum. Some operators have as their main object the narrowing of the vaginal lumen; others aim to pull up and keep in position all the displaced pelvic organs by shortening the round ligaments or anchoring the uterus on a higher plane from above. Several of these methods are frequently combined.

When the uterus is large and its weight is a factor in the production of the displacement, it is removed by either the abdominal or the vaginal route; and various methods have been devised to uphold the adjoining organs after this removal. In some cases the enlarged cervix alone is removed.

A slight degree of prolapse associated, as it generally is, with retroversion can sometimes be cured by curetting the uterus and repairing any existing lacerations of the cervix and perineum, the patient being treated in the manner suggested in the remarks on non-operative treatment, as soon as she begins to assume the erect position. When cystocele and rectocele coexist, the operations for both conditions should be made at the same time. Hegar's colpoperineorrhaphy with Stoltz's operation for cystocele is a very good combination in moderate degrees of prolapse, particularly when the patient is still of child-bearing age (Figs. 381–383). It may prove more advantageous to make a large and long oval denudation on the anterior wall, passing the stitches from side to side, to prevent shortening of the anterior vaginal wall.

The importance of a properly performed posterior colpoperineor-rhaphy can hardly be overestimated. The denudation should extend upward to an extent corresponding with the degree of prolapse, and should usually begin at the cervicovaginal junction. The stitches should be deeply placed, and should bring the severed and relaxed submucous structures at the side to the center of the denudation. As in these cases the lower end of the vagina is displaced backward, the posterior vaginal wall and perineum must be brought forward under
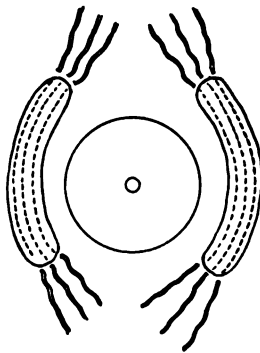
FIG. 369.—E. C. Dudley's operation for prolapse: lateral denudations as seen through the speculum; sutures in place, but not tied.
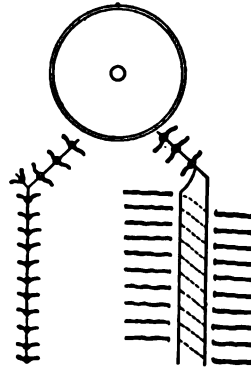
FIG. 370.—Sutures in place, before tying, on the right side; after tying, on the left side.
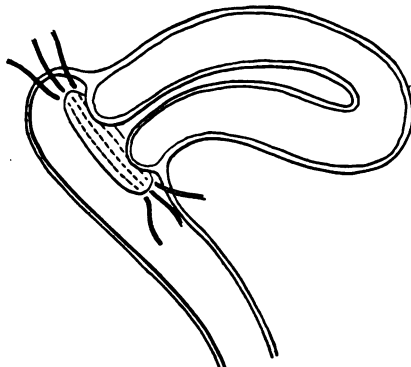
FIG. 371.—Lateral denudations on one side in sagittal section.
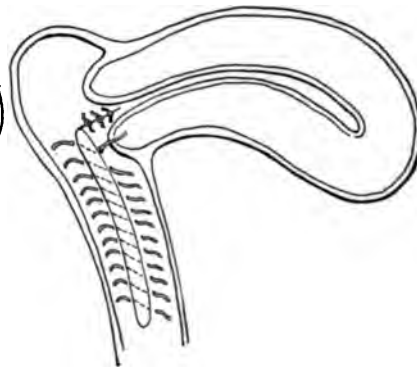
FIG. 372.—Lateral sutures on one side passed, but not tied.

the pubes to support the anterior wall. The mechanism and anatomical relation of the parts will be detailed later on in this chapter.

A logical operation for the treatment of procidentia, and one which is frequently successful in younger women, is the combination of lateral elytrorrhaphy and perineorrhaphy performed by E. C. Dudley. As stated by that author, this operation (Figs. 369–372) is designed to hold the uterus in position by restoring the normal angle between its long axis and the long axis of the vagina. The patient being in Sims's position, the cervix is held far back in the hollow of the sacrum with a

Sims speculum. The denudations are made as shown in the drawings, the primary denudations on each side of the cervix being about $\frac{1}{5}$ inch in width. The tying of these first sutures lifts the cervix upward and backward. The long denudations along the lateral sulci are $\frac{1}{4}$ inch wide, and terminate on either side of the urethra. The operation is always completed by restoration of the perineum and vaginal outlet.

Any of the operations mentioned may be advantageously combined with others designed to fix or alter the position of the uterus from above.

In elderly women hysterectomy is frequently the operation of choice for the cure of procidentia; and it has repeatedly proved successful after the failure of properly performed plastic operations. Even after hysterectomy, however, it sometimes becomes necessary to perform supplementary plastic operations, particularly in case of persistent cystocele. Hysterectomy may be performed through either the abdomen or the vagina. When made through a suprapubic incision, the cervix, if it is not removed, or the upper end of the vagina, should be carefully anchored by a silk ligature on each side, the remaining portion of the broad ligament being used for a support (Baldy).

In vaginal hysterectomy for prolapse, silk ligatures should always be used; the broad ligament should be tied off in sections, and each ligature of one side tied to the corresponding ligature of the opposite side.

Operations for Retrodeviations.—A slightly retroverted uterus will sometimes resume its normal position and function after curettage combined with repair of a lacerated cervix and perineum; but the majority of cases will require more thorough measures, adapted particularly to the direct correction of the difficulty. Those most commonly employed are: Shortening of the round ligaments (Alexander's operation); hysterorrhaphy; intra-abdominal shortening of the round ligaments, and vaginal fixation.

Alexander's operation is applicable to a limited number of cases in which there are absolutely no complications. As uncomplicated cases are exceptional, and may not need operation, because they present no symptoms, and as many lesions of the ovaries and tubes give but slight palpable evidence of their existence, it is evident that, despite its frequent performance, the proper sphere of this operation is extremely limited.

Hysterorrhaphy and intra-abdominal shortening of the round ligaments are the operations of choice for the great majority of retrodeviations; the first, for women not liable to future pregnancy; and the second, for all others. These operations can be performed through a very small incision close to the pubes, are virtually without danger, and possess the great advantages of permitting thorough pelvic inspection, and of making possible other operations on the pelvic organs, if required, through the same incision.

Vaginal Fixation.—Vaginal incision with fixation of the uterus, either by shortening the round ligaments or by stitching the uterus to the vaginal wall, is uncertain in its results. If successful, it may give rise to dystocia in future pregnancy. It is unsurgical to a degree, as it

means operating on possible complicating conditions through a limited and hampered field, distant parts of the pelvis being reached with difficulty. There is, moreover, a liability to bladder irritation after this operation, which is the most dangerous of these complications.

Vaginal incision through the posterior fornix, followed by drainage, with tampons placed in the cul-de-sac of Douglas, as practised by William R. Pryor of New York, is a valuable procedure in selected cases in which septic pelvic disease limited to the region immediately behind the uterus is recognized. In these cases, after incising and cleansing the diseased area, the adhesions are thoroughly loosened, and the uterus replaced and kept in position by long tampons introduced through the incision in Douglas's cul-de-sac, the tampons also favoring drainage.

Alexander's Operation.—An incision about 6 cm. ($2\frac{1}{3}$ inches) in length is made parallel with and 1.5 to 2 cm. (0.6 to 0.8 inch) above Poupart's ligament, extending from a point opposite the internal ring toward the spine of the pubes. The incision should involve all the tissues down to the round ligament, including the aponeurosis of the external oblique and the cremasteric muscle, avoiding the ilio-inguinal and genitocrural nerves. The ligament is seen as a small round cord lying along the lower part of the inguinal canal. It should be picked up and freed from all its attachments through the internal ring well into the abdomen; but the peritoneal cavity should not be opened. After the same process has been repeated on the opposite side, the ligaments may be freely drawn out for 8 to 10 cm. (3 to 4 inches), thus carrying the fundus of the uterus well upward and forward.

The ligaments are now laid along the entire length of the inguinal canal, the redundant part excised, and the remaining portions fixed by a row of buried catgut sutures, which should include the conjoined tendon, the round ligament, and the inner edge of Poupart's ligament from the internal to the external ring. The aponeurosis of the external oblique is closed over the ligament by a separate row of buried catgut sutures, and the skin united over all.

The danger of hernia following this method of closure of the wound is very slight.

The advantages of opening the entire inguinal canal over the short incision at the internal ring are: (*a*) The ligament can always be found; (*b*) it can be freed from its attachments at the internal ring and along the canal; (*c*) the traction on the uterus is more direct, thus assuring to it a better position.

Abdominal Hysterorrhaphy.—After a short incision has been made in the median line just above the pubes, the pelvis is carefully explored for disease of the uterine appendages or other pathological conditions. An incision 5 cm. (2 inches) in length is usually sufficient; and this may be prolonged if necessary. A silkworm-gut suture is then introduced on the right side, not more than 1 cm. (0.4 inch) above the pubic bone, passed through the fascia of the rectus muscle into the general abdominal cavity, through at least 1.5 cm. (0.6 inch) of the posterior uterine wall, 1 cm. (0.4 inch) posterior to the median line of the fundus, and thence to the corresponding point on the opposite side of the incision, beginning from the peritoneal side and including the same structures in inverse order, emerging 6 mm. ($\frac{1}{4}$ inch) external to the cut edge

of the rectus fascia. The suture is then pulled taut, to be sure that the uterus is brought into proper position, and its ends are grasped by forceps. The peritoneum and fascia in the vicinity of the suspension-stitch are now brought together by catgut sutures, and the silkworm-gut suture is carefully and firmly tied. This would better be done before the abdominal opening is closed, lest the silkworm-gut break while being tied, and in order that the finger may be swept around or the part inspected before closing. The remainder of the abdominal wound is then closed in the usual way. The suspension-stitch is applied behind the fundus, because in that way only can the uterus be properly replaced and held.

The writer has never used more than one stitch. Four of his cases have passed through subsequent deliveries; dystocia was present in 1 case, but in all 4 the uterus retained its anterior position. The liability to dystocia in subsequent pregnancies makes this operation objectionable in women of child-bearing age. Out of 60 cases, in a few of which suppuration of the abdominal wound occurred after this operation, the writer has been obliged to remove the suspension-stitch in 2 instances only.

Intra-abdominal shortening of the round ligaments for pathological retrodeviation, first introduced by Gill Wylie, of New York, and later employed by Ruggi, of Bologna, has attained deserved popularity as an operation for the restoration of the uterus to the position of normal anteversion.

Wylie's operation is as follows : After the abdomen has been opened by median incision, the uterus is replaced. A tenaculum is now inserted in the round ligament, midway between the uterine cornu and the internal opening of the inguinal canal, the ligament drawn out of the parietal wound, and, after freshening of its opposing surfaces, three silk ligatures are passed around and through it. The opposite side is treated in a similar manner. The three ligatures are applied at sufficient distances to take up all the slack of the ligament, and, by doubling the ligament upon itself, to make it reasonably taut. An Albert Smith pessary is then inserted in the vagina to maintain the uterus in correct position during healing of the wound.

In the various operations the same principle is involved; namely, shortening the round ligaments to a sufficient degree to restore physiological anteversion, the amount of shortening of the round ligament varying with the degree of retroversion. For this, no arbitrary rule can be laid down.

Vaginal Fixation.—The uterus being drawn downward and backward by volsella fixed on the anterior lip, a slightly curved incision is made anterior to the cervix at the vaginal junction. This is joined at its mid-point by a second incision, 2 cm. (0.8 inch) in length, parallel to the vagina and directed toward the meatus, care being taken not to penetrate too deeply, lest the bladder be wounded. The loose cellular tissue between the uterus and bladder is carefully separated from the uterus, and pushed upward and forward until the peritoneal fold is reached. This is now incised and the uterus exposed. Two fingers are introduced, the opening stretched, and the uterus freed from adhesions. Now, by gently grasping the body of the uterus with a volsel-

lum, that organ can be brought further down, and by successively grasping the uterus with a volsellum, each time at a higher point, the
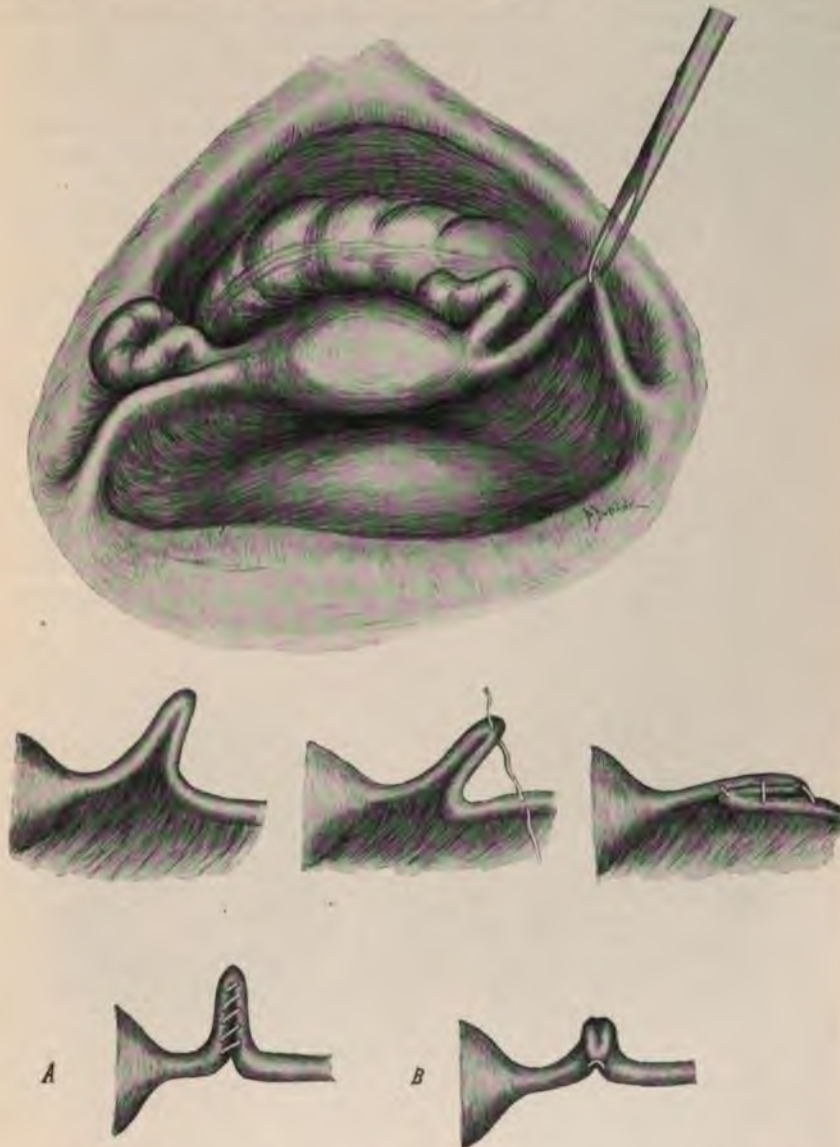
FIG. 373.—Intra-abdominal shortening of the round ligament: *A* and *B*, Palmer Dudley's disposition of the duplicated ligament.

operator can gradually antevert and anteflex the organ until it is gently extruded through the opening into the vagina. Any operation required upon the uterus or appendages can now be done, care being taken to

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recognize septic conditions, and to control all hemorrhage before the anchoring stitches are applied, since, by neglecting these precautions, many operators, after beginning this operation, have been obliged to finish by performing a hysterectomy. A suture, preferably of silk-worm-gut, is now passed through the vaginal flap just below the upper point of the vertical incision, 6 mm. ($\frac{1}{4}$ inch) from its margin, through at least 12 mm. ($\frac{1}{2}$ inch) of uterine tissue, exactly at the middle of and close to the fundus, and then through the vaginal wall at a corresponding point on the opposite side of the incision. A second suture is passed 5 mm. (0.2 inch) below the first, and in the same manner. The sutures are now held taut by an assistant, and the vaginal wound closed with catgut, after which the two anchoring sutures are tied. These sutures are removed after three or four weeks.

Some operators, notably Byford, grasp the round ligaments, shorten them by suturing, and include them in the sutures which close the vaginal opening.

If pus or septic conditions are encountered, it is safer to make a curved incision through the posterior vaginal cul-de-sac and introduce a gauze drain.

LACERATION OF THE CERVIX UTERI.

As the uterine cavity becomes enlarged during the later months of pregnancy, the cervical canal is gradually effaced, until at term there remains only a large ovoid uterine sac, with a small, flat opening cor-
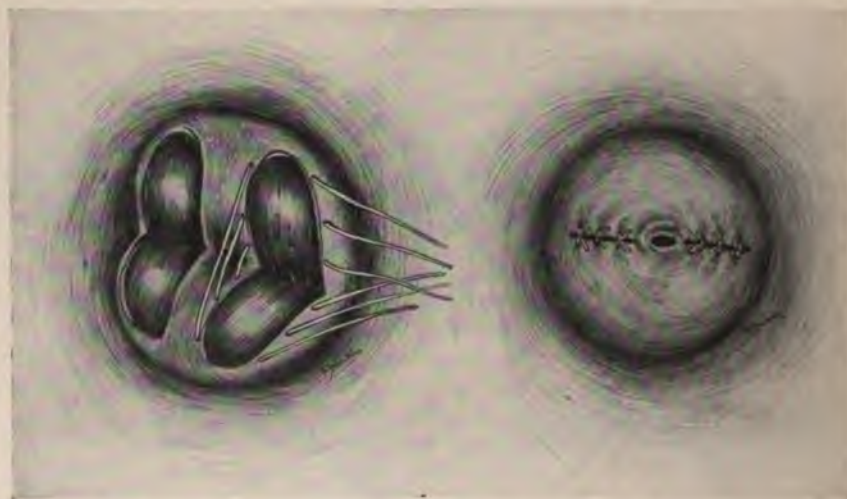
FIG. 374.—Denudation and position of the sutures in simple bilateral trachelorrhaphy. The sutures may be either of catgut or of silkworm-gut.

responding to the external os. As labor progresses the lips of this opening become gradually attenuated, until it feels like a tense sheet of rubber of the thickness of paper. As the head emerges from the uterus, laceration of the cervix occurs in almost all cases. When the
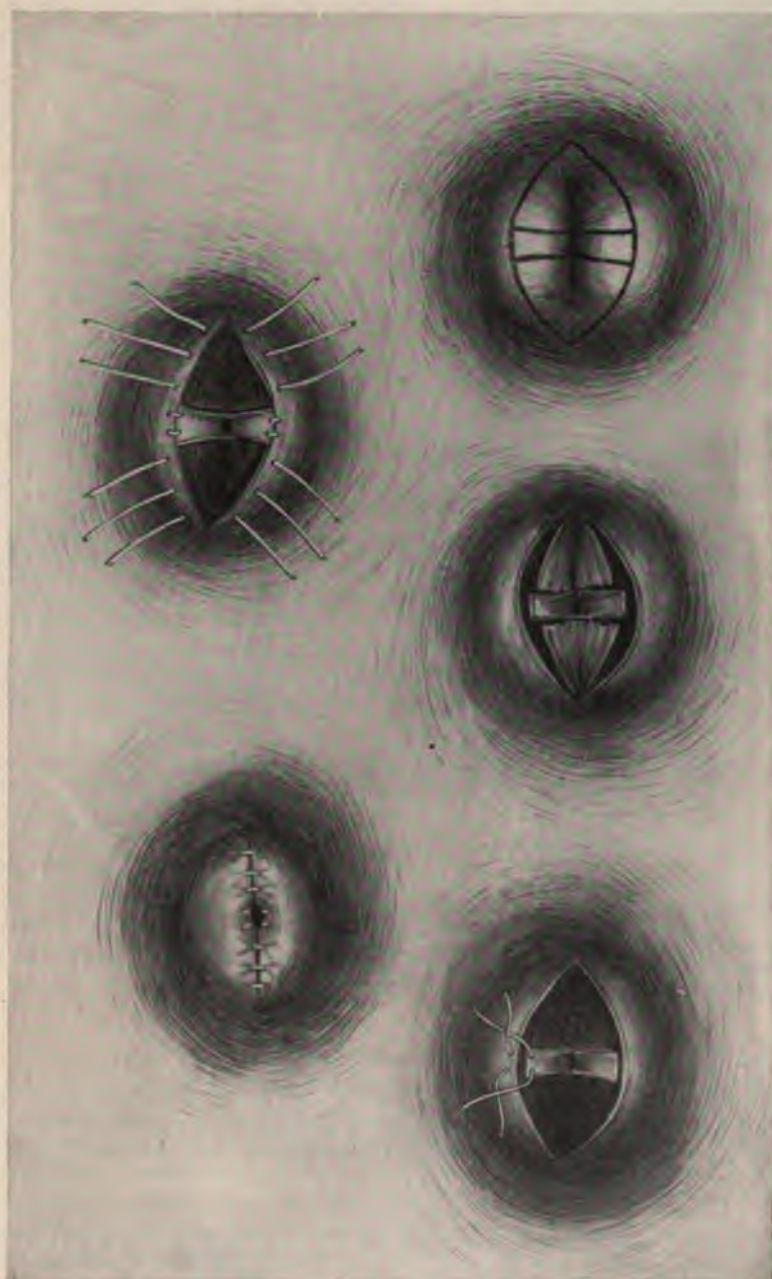
Fig. 375.—Henrotin's method of amputating the cervix.

uterus contracts and the cervix is restored, the external os is seen to be lacerated in various directions. Sometimes the tear extends from the canal outward on one—generally the left—side to the vaginal junction, or even out on the vaginal wall. Sometimes this injury occurs on both sides, forming what is known as a bilateral laceration. More rarely, the laceration extends through the anterior or posterior lip, or radiates in several directions, producing what is known as a stellate laceration. The lips produced by these lacerations are often everted, forming a pouting orifice, covered by what was originally the cervical mucosa.

Friction of the everted cervix upon the vaginal wall is followed by infection, resulting in erosion, with leukorrhea, and eventually in cervical hyperplasia. Neglected cervical tears apparently act as foci of irritation in the aggravation of neuroses; and the frequent coexistence of cancer and laceration of the cervix makes it impossible to ignore the possible connection between these two conditions.

These injuries to the cervix are frequently the starting point of metritis and other septic conditions of the genital tract.

When the lips of a laceration are only slightly everted, the lesion is easily recognizable; but when the eversion is considerable and the surface eroded, the original injury may be overlooked. By placing the patient in Sims's position, grasping each lip with a tenaculum and drawing them toward the outlet, the laceration becomes at once apparent.

Operation.—To T. Addis Emmet is due the sole credit for recognizing and advising a remedy for this condition.

The steps of the operation, which is termed *trachelorrhaphy* (Fig. 374), are made plain by the accompanying illustrations. The following points should be kept in mind, in order to secure the most satisfactory results:

The cicatricial plug in each angle must be completely removed.

The strip of mucous membrane left in the median line, which is to serve as the mucous lining of the restored cervical canal, must be of sufficient width to prevent stenosis.

Sufficient tissue should be removed on each side of both lips to allow them to come into apposition without tension.

All the sclerosed tissue must be removed. When this is too extensive for removal by denudation, it may be necessary to resort to amputation of the cervix, as illustrated in Fig. 375.

LACERATION OF THE PERINEUM.

This injury usually occurs during the passage of the child through the introitus vaginæ or during forcible manual or instrumental delivery. It is especially frequent in primiparæ with flat pelves or narrow or rigid vaginal outlets.

Lacerations of the perineum vary in extent from a slight tear at the fourchette to a rent involving all the perineal structures, and even extending into the rectum. Lacerations which do not involve the sphincter ani muscle are known as *incomplete;* when the sphincter ani is torn, the laceration is termed *complete.* Most extensive rupture of the submucous muscular and fibrous structures of the pelvis, with

resultant relaxation of the vaginal walls and outlet, may occur in tedious labors, with only slight, or even without any, injury to the covering mucous membrane.

The correct position of a normal uterus, vagina, rectum, bladder, and urethra depends greatly upon the integrity of the pelvic floor. It may be stated that in the great majority of perineal lacerations, the prominent physiological defect is produced by faulty or insufficient action of the levator ani muscle. This muscle, with its fasciæ, lifts the rectum and vaginal outlet forward under the pubic arch, produces the normal lower curve in both these organs so necessary to pelvic support, and maintains

FIG. 376.—Emmet's operation for complete laceration of the perineum, showing area of denudation.

FIG. 377.—Emmet's operation: sutures in position, but not tied. Sutures at and below *A* and *C* are of silkworm-gut; above, of catgut. Rectal sutures are applied from above downward, each being tied and cut as short as possible for a safe knot immediately after application.

the so-called perineal body in its proper position. Rupture or excessive laceration of the levator ani and its fasciæ allows the rectum and anus, with the perineum, to fall back toward the coccyx; produces a gaping vaginal outlet and rectocele, with descent of the posterior vaginal wall; obliterates the normal acute angle with the uterus above, which is so necessary to prevent prolapse; and, in addition, greatly weakens the support of the anterior vaginal wall and favors cystocele.

In operating to repair perineal injuries, it is not sufficient simply to lessen the size of the introitus vaginæ, but the operation must always have as its object the restoration of the normal relation of fasciæ and muscular structures. No operation is applicable to all cases.

Most lacerations begin in the vagina, parallel to the outlet and opposite, but posterior to, the fourchette; thence they extend upward in the sulci between the posterior and lateral walls of the vagina. The external part of the outlet is pushed forward before the advancing head, and soon ruptures. In rare cases a central deep furrow is plowed through in the median line. This probably occurs only after very long and tedious labors, in which considerable edema exists before labor is accomplished. This condition is therefore relatively less common in modern times and with modern methods.

The space at our disposal is not sufficient for the description of even a small portion of the many operations devised by different sur-

FIG. 378.—Emmet's operation : catgut sutures in sulci tied and cut short. Rectal sutures, with the exception of lowest one, tied and cut. Posterior vaginal wall drawn down and everted to show sutures in position.

FIG. 379.—Emmet's operation: perineal sutures tied; operation complete.

geons for this condition. Therefore the only operations which will be here described and depicted are those which have, in the opinion of the writer, been most generally satisfactory and successful.

The perineal body upholds the lower ends of the anterior rectal and posterior vaginal walls, directing the former backward and the latter forward. It is the point of union of the levator ani and transversus perinei muscles and their ligamentous fasciæ, and is traversed by the anterior half of the sphincter ani muscle.

Any ununited laceration of this body is followed by retraction and separation of these muscles; and any operation, to be successful, must bring these muscles and fasciæ back to the median line. The gap between the torn and separated muscle-ends soon becomes filled in by
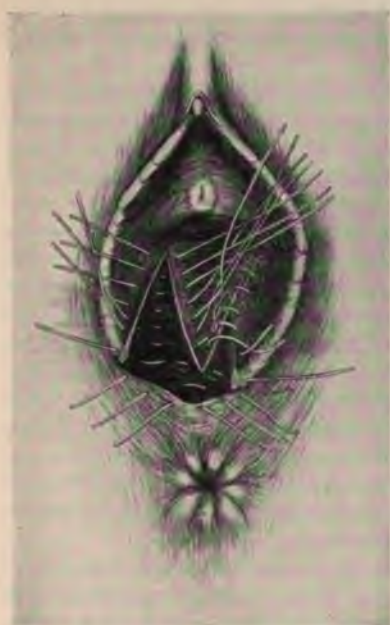
FIG. 380.—Emmet s operation for incomplete
laceration of the perineum.

FIG. 381.—Cystocele and rectocele.

FIG. 382.—Stoltz's operation for cystocele.
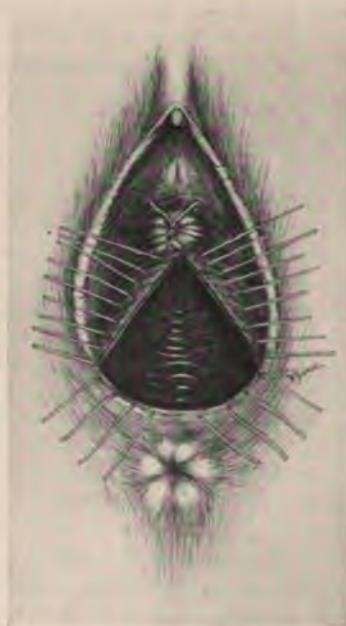
FIG. 383.—Hegar's (triangle) operation for
rectocele following Stoltz's completed opera-
tion for cystocele.

the relaxed vaginal mucosa and scar-tissue. If the laceration has existed for a considerable time, cystocele and rectocele in many instances supervene.

The *operation* best calculated to meet the conditions produced by laceration of the perineum and relaxation of the vaginal outlet is that devised by T. Addis Emmet, the steps of which are so clearly shown in the accompanying illustrations (Figs. 376–383) that little further description is necessary.

The so-called " flap-splitting" methods promulgated by Lawson Tait have been much in vogue. The operation as originally performed by Tait does not appear to the writer to fulfil the indications required. Modern perineorrhaphy means much more than mere vulvar restoration, which is practically all that is attained by this procedure. In case of a complete laceration, it furnishes a rapid method of reuniting the torn sphincter ani, but does not properly restore the function of the pelvic floor. It temporarily relieves and retards the development of rectocele, but it does not effect a cure.

Every operation for laceration of the perineum should have for its object the reproduction of the original laceration as far as possible, correct apposition of the parts, and reunion.

The modifications of Tait's operation by Byron Robinson and others more nearly fulfil the indications; but even these are deficient in important particulars. The claim made for the flap-splitting operation, that no tissue is lost, is not valid. The only tissue removed by denudation is mucous membrane, which is always superfluous, and scartissue, which is invariably harmful.

INVERSION OF THE UTERUS.

This term refers to that rare condition in which the uterus is turned inside out. It is caused by a relaxation or paralysis of the circular fibers of the lower segment of the uterus, which permits inversion of the upper portion into the cervix. When once engaged beyond a certain point, there is a tendency on the part of the inversion to become complete. About 85 per cent. of all cases are incident to recent delivery; and a large proportion of the remainder result from the presence of a tumor attached near the fundus, which in attempts at extrusion becomes engaged in the cervix without losing its attachment above. If the attachment persists and the tumor does not become sufficiently pedunculated, it naturally drags the fundus uteri with it, and a complete or partial inversion results. When the accident is sudden, considerable shock and collapse occur; hemorrhage, alternated and combined with foul vaginal discharges, dragging pelvic pains, and usually signs of sepsis supervene, the general health suffering materially.

Examination reveals that the vagina is filled with an ovoid bleeding mass, while on careful palpation above the pubes the uterine body cannot be found. When a tumor is attached to the fundus, the inversion may be incomplete and the difficulties of diagnosis increased. Excessive care in diagnosis is necessary, and the possibility of partial inversion should be constantly kept in mind during vaginal operations on

submucous growths. Bimanual examination of the completely inverted uterus under anesthesia rarely fails to demonstrate a shallow depression above the point where the uterus should normally be situated. The uterine ends of the Fallopian tubes are, of course, dragged down into the cavity formed by the inversion; but the abdominal portion of the tubes and the ovaries can generally be felt just at its brim.

Treatment.—Recent inversions can often be reduced by manipulation, sometimes even with great ease; but in such cases there is always a tendency to recurrence. This tendency may be obviated by the introduction of a pair of sutures, which hold the lips of the cervix together, and are removed after a few days.

When an inversion has become chronic, however, it resists all efforts at reduction by manipulation. Great surgical acumen is needed to determine whether such efforts should be persisted in, or even tried. The chronicity of the case and the density and compactness of the strangulating and constricting areas act as guides to the operator, who must remember that death may result from injury due to long-continued, forcible attempts at reduction.

A number of operations have proved successful in reducing inversions. The abdomen may be opened and the ring dilated while an assistant exerts pressure upon the fundus from below. If the ring is not dilatable, it may be incised, preferably posteriorly in the median line. Küstner states that with a roomy vagina, the posterior cul-de-sac may be opened and the constricting ring incised by this route, the wound being repaired by sutures after reposition of the uterus.

Finally, the uterus may be amputated through the vagina, just below the constricting ring of the external os, and an anterior and a posterior flap made and united by sutures. In this procedure care must be taken to place the sutures before allowing the stump to retract. If this precaution is not taken, serious hemorrhage may follow.

When a tumor attached to or near the fundus has dragged the uterus into inversion, removal of the tumor will usually be followed by spontaneous reduction of the inversion without manipulation. This may occur so quickly that, unless the surface to which the tumor was attached has previously been carefully united, hemostasis may be prevented by disappearance of the inversion. Care must also be taken lest the general peritoneal cavity be unexpectedly opened. The walls of the uterus may be greatly attenuated at a point opposite the attachment of the tumor; or traction upon the latter, to bring it well into view, may produce a depression on the peritoneal side, which may easily be opened.

SYMPHYSEOTOMY.

By symphyseotomy is meant division of the symphysis pubis. The intention of this operation is usually to increase the pelvic diameters by separating the innominate bones, thus permitting delivery of a living child. It is also occasionally performed to facilitate certain operations on the bladder.

The increase in the conjugata vera obtained by symphyseotomy is

from 1 to 2 cm. (0.4 to 0.8 inch); and this gain marks the limits of
the operation from the mechanical side. Whenever the disproportion
between the child's head and the conjugata vera is such that an increase
of 1 to 2 cm. in the latter will permit the passage of the head, sym-
physeotomy is indicated, providing the other requisites are present.
These requisites are a conjugata vera of not less than 7 cm. ($2\frac{3}{4}$ inches);
a living child; the os uteri dilated; no other obstruction, bony or other-
wise, to the ready delivery of the child through the natural passage;
the condition of the mother such as to warrant operation.   More
specific indications, methods of pelvimetry, etc. will be found in the
standard text-books on obstetrics.

The technic of the operation is as follows: The field of operation is
shaved and thoroughly cleansed, and the bladder emptied by a cathe-
ter.   The incision is made over the symphysis, and extends from 2 to
3 cm. (0.8 to 1.2 inches) above the bone to within 1 cm. (0.4 inch) of
the clitoris.   The space between the recti muscles is divided, and the
bladder and prevesical fat separated from the bone, by the finger intro-
duced posterior to the symphysis, well down to the arch.   The soft
parts are freely separated from the symphysis in front, at the sides, and
downward to the arch.

The symphysis is now divided with a sharp scalpel from before back-
ward, the bladder being guarded by a finger introduced posteriorly.
During this part of the operation each thigh should be supported by
an assistant, to prevent sudden separation of the symphysis, with lac-
eration of the soft parts.   The ligamentum arcuatum should not be
divided, but should be carefully detached from the arch, keeping close to
the bone.   The deep perineal fascia which extends transversely between
the rami of the pubes should now be detached from the bone on each
side with a blunt-pointed bistoury, upon the finger as a guide.   As the
tense fibers of this fascia are detached from the arch, it will be seen that
the space at the symphysis gradually widens.   When these fibers are
felt to be no longer tense, it will be found that the symphysis has sepa-
rated as widely as it can without straining the sacro-iliac joints.   The
separation will usually amount to from 4 to 6 cm. ($1\frac{3}{4}$ to $2\frac{3}{8}$ inches).
When the ligament and fascia have been thus carefully detached later-
ally from the bone, all danger of hemorrhage from laceration of the
soft parts is effectually avoided.

If the ligament and fascia are not detached from the arch in the
manner described, but the bones are forcibly separated, severe hemor-
rhage from laceration of the erectile tissue and large venous plexuses
of this region may ensue.   This hemorrhage is best controlled by pack-
ing the wound with gauze, making at the same time counterpressure
in the vagina.   The symphysis should be completely divided and sepa-
rated to its fullest extent in all cases before attempting delivery of
the child. If a pain occur during the operation, pressure should
be made by the assistants against the sides of the pelvis, to prevent
sudden giving away of the undivided tissues, with consequent laceration
of the soft parts.   Labor may be terminated by the forceps or left to
nature, as may appear advisable.   The anterior wall of the vagina
should be well protected, and kept pushed up above the head as the
latter descends.   Temporary, or rarely persistent, incontinence of urine

may follow injury of the urethra, and a urethral fistula may follow such an injury.

In closing the operation wound, suture of the bone is unnecessary. The soft parts should be sutured in the usual way, and a small gauze drain left in the lower angle of the wound for twenty-four to forty-eight hours. The bones are kept in apposition by means of a broad strip of rubber adhesive plaster encircling the pelvis. A trough-bed, made by placing sand-bags or other material along the sides of the patient, is of distinct advantage in holding the bones together.

The patient should be kept in bed three or four weeks. The symphysis almost always unites firmly by fibrous union, and subsequent ill-effects of the operation have seldom been noted.

CESAREAN SECTION.

Cesarean section is a laparo-uterotomy for the delivery of a child at or near term. When, owing to obstruction, the child cannot be delivered by the natural channel, recourse must be had to Cesarean section, symphyseotomy, or craniotomy. The success that has attended Cesarean section and symphyseotomy under modern technic and asepsis has made craniotomy improper when the child is alive. Symphyseotomy is limited to those cases in which a contraction of 1 to 2 cm. (0.4 to 0.8 inch) in the conjugata vera is the only obstacle to delivery. The time of election for Cesarean section is when, in the opinion of the operator, the woman is at term, irrespective of the actual advent of labor; but emergencies frequently arise in which operation becomes necessary after labor has commenced.

Operation.—After thorough preparation of the patient, an incision 3 inches in length is made in the median line downward from about an inch below the umbilicus. Two fingers are now introduced into the peritoneal cavity as a guide, and the incision extended both downward as far as possible without wounding the bladder, which may rise in the pregnant woman 2½ or 3 inches above the pubes, and upward, circling to the left of the umbilicus to a variable distance, depending upon the size of the uterus. The incision usually is from 6 to 8 inches in length. When the abdominal cavity has thus been opened, careful inspection and examination of the uterus and peritoneal cavity should be made to determine the further plan of operation. This is especially important when operating on women after prolonged labor. A boggy ecchymosed uterine wall, or a dark infected peritoneal surface, or the presence of effused fluid in the cavity generally indicates sepsis, and demands removal of the uterus.

An assistant now places a hand on either flank of the patient, and, by pressing the uterus forward, causes it to bulge in the incision, maintaining this pressure until the uterus has been emptied and begins to contract. This steadies the uterus, aids in controlling hemorrhage, and prevents escape of amniotic fluid into the abdominal cavity.

With the knife held vertically, an incision 2 cm. (0.8 inch) in length is made in the median line just above the reflection of the peritoneum, through the uterine wall down to the mucosa. The left forefinger is introduced through the incision and pushed into the uterine cavity. If the uterine wall is thin, the blunt blade of a scissors is introduced on the finger as a guide, and the anterior uterine wall divided for about 5 inches in the median line. If the wall is thick, a probe-pointed knife is used for this purpose. The whole hand is then pushed into the uterine cavity, the membranes ruptured, and the child extracted by its most convenient presenting part. If the placenta is encountered during this step in the operation, it is detached from the uterine wall and pushed aside. The cord is now divided between two forceps, and the child given to an assistant. The hand is again introduced into the uterus and the placenta and membranes carefully detached and removed, without waiting for spontaneous detachment. The assistant who has maintained pressure on the flanks now forces the uterus out through the abdominal incision, aided, if necessary, by the hand of the operator pushed above the fundus. A second assistant grasps the body of the uterus on either side, and compresses, if possible, both the uterus and the vessels in the broad liga-

ment. The entire field of operation is now cleansed, and hot, wrung-out sponges placed over the intestines. While this is being done, the patient may advantageously be placed in the Trendelenburg position. Hemorrhage may be controlled by packing the uterine cavity with hot sponges while the deep sutures are being applied.

The incision in the uterine wall is closed by three sets of sutures. The deep sutures are first placed in position about 1½ cm. (0.6 inch) apart. Each suture enters the peritoneal surface of the uterus about 12 to 16 mm. (0.47 to 0.63 inch) from the edge of the wound, penetrates the serous and muscular coats, and emerges in the wound just external to the mucosa. It then is reinserted at a corresponding point on the other side, passes through the muscular and serous coats, and emerges opposite the point of entrance. Between each pair of deep sutures is inserted a coaptation-suture, which includes about one-half of the wall of the uterus. Great care must be taken in the application of both deep and coaptation-sutures to secure close and perfect coaptation and entirely to control hemorrhage. The third suture is a continuous superficial suture, which includes only the peritoneal coat of the uterus, and is so applied from side to side as to cover completely the two sets of sutures just described. The deep interrupted sutures are of heavy Chinese silk, the coaptation-sutures of catgut, and the continuous superficial suture of light Chinese silk.

The selection and application of sutures are most important factors in the success of the operation. Silkworm-gut irritates, and may cut through or favor late local suppuration ; catgut softens, and the knots slip. Braided silk is difficult to sterilize ; and if the slightest local sepsis occurs, it promotes capillary drainage and may establish communication between the interior of the uterus and the peritoneal cavity. A wide, loose-meshed Chinese silk, which is easily sterilized, is the best suture-material and furnishes the greatest security when applied in the manner detailed above.

Many authors advocate drainage through the lower angle of the abdominal wound. If the operation has been properly performed and sepsis is not present, drainage is unnecessary. If, however, the uterus or peritoneal cavity is infected, the uterus should be extirpated.

In the after-treatment of Cesarean section, it must be borne in mind that high temperature, foul lochial discharge, and the presence of a tender area above the pubes are indications which call for the removal of the three or four lower abdominal sutures and the insertion of a drain.

When future pregnancy is deemed inadvisable, the Fallopian tubes may be doubly ligated and divided between the ligatures. After thorough cleansing, the uterus is replaced, the abdominal wound closed by through-and-through sutures, reinforced by catgut sutures between the different layers, and a binder applied over the dressings.

Porro's Operation (*Supravaginal Amputation, or Total Extirpation of the Uterus*).—Porro's operation as at present understood is the removal of the uterus after Cesarean section. It is indicated by infection of the uterus or peritoneal cavity, by uncontrollable hemorrhage during Cesarean section, by rupture of the uterus, and by pre-existing tumors or other irremediable obstructions to future normal delivery. It is also advised in connection with removal of the ovaries for the cure of osteomalacia. Up to and including delivery of the child, the operation is virtually the same as that for Cesarean section. The same care, however, need not be taken in making the uterine incision ; and the location or direction of that incision within reasonable limits is a matter of no moment. A rubber cord should be passed around the uterus at its neck as soon as the abdomen has been opened, if it can be done without unduly extending the abdominal incision. When the cord is tightened, hemorrhage is effectually controlled. Immediately upon delivery of the child, the hand is introduced or the fingers hooked into the uterus, which is then pulled out of the abdominal cavity. Unless the placenta is free, no time need be taken for its removal. Sponges are now inserted to protect the general peritoneal cavity ; and a wire or elastic ligature or serre-nœud applied below the temporary constricting

band, at a point as near the external os as can be determined by the anatomical relations. The uterus, tubes, and ovaries are amputated about ¾ inch above the constriction. The stump is brought into the lower angle of the abdominal wound, and held in position by the adjacent through-and-through sutures which close the abdominal wound, additional sutures being applied to hold it in position if deemed advisable. Iodoform gauze is packed carefully around the wound and a large dressing applied.

Many modifications of this simple and rapid method, with extraperitoneal treatment of the stump, have been carried out. The tendency of each surgeon is to treat the emptied uterus exactly as he would treat a fibroid. Some surgeons isolate the vessels and ligate them separately, coapt the raw surfaces, cover the stump with the adjoining peritoneum, and entirely close the abdominal wound without drainage. Others, notably Polk, of New York, ligate the vessels and remove the uterus and cervix entire, draining with gauze through the vagina. Others do not remove healthy ovarian tissue. It must be clearly borne in mind that there is much more risk of sepsis in leaving the large stump of a pregnant uterus in the pelvis without drainage than is incurred when the small cervix of a fibroid uterus is treated in the same manner.

FISTULA.

Fistulæ of the genital tract may be divided into urinary and fecal fistulæ. The varieties of the first class are vesicovaginal, vesico-uterine, vesico-uterovaginal, urethrovaginal, ureterovaginal, uretero-uterine ; of the second division, rectovaginal, enterovaginal, and enterovesical. The names sufficiently indicate the anatomical locations.

Genital fistulæ are most frequently caused by injury received during labor, either directly, from pressure of the presenting part or instrument ; or indirectly, from necrosis due to preceding pressure or inflammation. They may also be caused directly by trauma during operative procedures. Other causes are defective development, ulcerative or suppurative processes due to syphilis, tuberculosis, or malignant disease, pressure from foreign bodies, pessaries, etc.

Urinary Fistulæ.—**Vesicovaginal fistula** is the most common variety. The characteristic symptom is discharge of urine through the vagina ; but this is often preceded by bloody vaginal discharges, hematuria, and dysuria, until the necrosis has so far advanced that the fistula is patent. The diagnosis depends upon the discharge of urine through the vagina and the determination of the location of the fistulous opening by touch and inspection. When the fistula is large, its opening may be felt upon digital examination. In some cases, instead of an opening, a soft, protruding mass—the extruded vesical mucosa— can be felt. When the fistula is small, it may be necessary to inject milk or other colored fluid through the urethra into the bladder, and, by noticing its point of exit, locate the fistula.

Treatment.—Very minute vesicovaginal fistulæ may often be cured by simply freshening or cauterizing the edges, and draining the bladder through a self-retaining catheter introduced into the bladder through

the urethra, and retained for a week or ten days. For this procedure anesthesia is not necessary and sutures may be dispensed with.

Fistulæ of moderate dimensions, the edges of which are soft and can be approximated by tenacula without tension, can ordinarily be cured by freshening the edges, and bringing them in close approximation by careful suturing. The denudation should completely surround the opening, should be about $\frac{3}{8}$ inch in width, and, beginning at the vaginal mucous membrane, should be uniformly bevelled down to, but should not include, the vesical mucosa. The sutures should be of fine silkworm-gut, should be introduced not more than $\frac{3}{16}$ inch apart, should pass through the entire thickness of the vesicovaginal septum, with the exception of the vesical mucosa, and should be so applied that the line of approximation will be transverse. Between these sutures very fine superficial catgut sutures may be applied.

In suitable cases a flap-splitting method may be employed, in which the septum is split for a distance of $\frac{5}{8}$ inch from the edge of the fistulous opening, which is then closed by fine interrupted buried catgut sutures applied to the outer surface of the vesical flap, care being taken to avoid inclusion of the mucosa. The vaginal flap is united by silkworm-gut sutures in the manner already described.

Complicated cases may require special procedures. Cicatricial contraction or loss of substance may prevent approximation of the edges. For the repair of this condition, most intricate plastic operations have been performed. The base of the bladder may be restored by flaps transplanted from the adjacent vaginal mucosa. The vesical mucosa may be detached from the submucous structures and brought down to be sutured to the denuded lower edge of the fistula. It may even be necessary in some cases to separate the uterus from the bladder as far as the vesico-uterine peritoneal fold, in order to obtain sufficient tissue for approximation. Vesicovaginal defects have been closed by direct suture of the bladder-wall after abdominal section and separation of the uterus from the bladder; and the latter has also been sutured from the inside through a suprapubic opening.

After all operations for vesicovaginal fistula, a self-retaining catheter should be introduced into the bladder through the urethra, and allowed to remain for from five to ten days.

Vesico-uterine Fistula.—Vesico-uterine fistula is usually due to anterior laceration of the cervix. The *diagnosis* is made by demonstration of the escape of urine through the cervix uteri. It may be differentiated from uretero-uterine fistula by injecting colored fluid into the bladder, when, if vesico-uterine fistula exists, the fluid is discharged through the cervix.

Drainage of the bladder through a permanent catheter should be tried faithfully for two weeks; and it may even be advisable to drain the bladder into the vagina through an artificial vaginal fistula for several weeks before proceeding to direct operation for closure of the fistula.

If these means fail, the cervix may be divided, the fistulous tract uncovered and denuded, and the wound closed by sutures through the uterine tissue. A better plan, however, is to separate the uterus from the bladder through an incision in the anterior fornix, to a point well

above the opening in the bladder, and to close the vesical opening with fine silkworm-gut sutures. The vagina is then packed with gauze for ten days, until the stitches are removed. If the lips of the incision in the anterior vaginal fornix fall well together, they need not be sutured.

Vesico-uterovaginal Fistula.—In this variety there are two fistulous tracts: one leading into the cervix; the other into the vagina. This condition most frequently follows laceration by the obstetric forceps or other instruments. It may rarely be caused by sloughing, the result of pressure-necrosis.

When the defect is not too extensive, the operation is identical with that detailed above for the closure of vesico-uterine fistula, plus denudation and closure of the vaginal portion of the fistula. After separation of the cervix from the bladder, two openings into the latter will be found, unless the intervening tissue has been removed in the necessary dissection. These openings may, as a rule, be made into one, and this large opening closed in the usual manner.

When the loss of tissue is extensive, the anterior lip of the cervix may be denuded and utilized to close the defect. If the anterior lip has sloughed away, the posterior lip may be employed for the same purpose. This method, however, possesses the disadvantage that ever thereafter the woman must menstruate *per urethram.*

Urethrovaginal fistula may occur, though rarely, as the result of puerperal injuries; it is more often found as a sequel of ulcerative processes due to syphilis, tuberculosis, or malignant disease; or associated with injuries to the base of the bladder. It is often artificially created to relieve urethritis or dysuria. It rarely occurs alone, but is coexistent with vesicovaginal fistula.

The best adapted operations often fail to cure this variety of fistula because of the spasmodic action of the sphincters of the urethra, which causes the stitches to tear out. The urethra may, however, be set at rest by the introduction of a small flanged rubber catheter passed through an artificial vesicovaginal opening.

Ureterovaginal fistula may involve one or both ureters, and may be congenital or acquired. The latter variety is usually observed after labor in which a laceration into the vault of the vagina has taken place. The *diagnosis* may be made by observing that the urine is discharged into the vagina intermittently in jets, that urine is also passed regularly from the bladder, and that colored solutions injected into the bladder do not pass into the vagina.

Congenital fistulæ may open in any part of the vaginal wall, even so low down as to be adjacent to the meatus urinarius.

Treatment.—A small ureteral fistula involving only one wall of the ureter, and located well down upon the anterior vaginal wall, may sometimes be cured by direct closure of its orifice with fine silk sutures. Sometimes it is better to dissect out the ureter for a distance of $\frac{1}{2}$ to $\frac{3}{4}$ inch, and turn it into the bladder through a buttonhole incision. Great care should be exercised to prevent leakage. To this end, the sutures should be of very fine silk, and should be carefully applied very close together. Those sutures which immediately adjoin the ureter should be passed through its walls, not including the mucosa, in order to fix the ureter securely in its new position. Occasionally it may be advisa-

ble to make an artificial vesicovaginal fistula, at least 1 cm. (0.4 inch) in diameter, close to the ureteral fistula, and to close this double defect by denuding around both orifices and uniting the wound by sutures.

In fistulæ situated higher up in the vagina, and especially in those following faulty vaginal hysterectomy, closure by plastic operations performed through the vagina is impracticable. In such cases the abdomen is opened and the lower end of the ureter dissected out downward, if possible, as far as the fistula, and upward toward the brim of the pelvis sufficiently high to allow of its implantation into the bladder without tension. Sometimes the bladder may be partially loosened from its pubic attachments, so that the implantation may be made with less tension. Before being implanted, the end of the ureter should be slit up for a few millimeters, in order to insure its patency. While the ureter is being securely fixed in its new position by fine silk sutures passed through the external coats of the bladder and ureter at the margins of the vesical wound, the end of the ureter should be securely held by a forceps passed into the bladder through the urethra. When all other means have failed, nephrectomy is the operation of last resort.

Uretero-uterine Fistula.—The ureter may discharge directly into the uterus, forming a uretero-uterine fistula. Urine escapes from the cervix, but colored fluid injected into the bladder does not pass out by this route.

Vesical implantation of the ureter, as just described, and nephrectomy are the only means at our command for the cure of this condition.

Fecal Fistulæ.—**Rectovaginal Fistula.**—When this condition is found in the upper vagina, it is commonly due to an extension of malignant disease, to ischiorectal abscess, or to operations involving incision of the posterior vaginal wall. In the lower vagina it is most frequently caused by a complete rupture of the perineum imperfectly cicatrized or operated upon, with only partial closure, leaving an opening into either the vagina or vulva. Syphilis, tuberculosis, pressure-necrosis (from labor, instruments, or badly fitted pessaries), and burrowing pus are also factors in the production of this variety of fistula. The *symptoms* are escape of feces or gas through the vagina. The *diagnosis* is made by inspection, passage of a probe, palpation of the anterior surface of the rectum, or injection of milk or colored fluid into the latter.

Treatment.—Fistulæ of this kind in the upper vagina should never be closed by operation until at least two months after their occurrence, as the majority will close spontaneously under systematic vaginal douching or packing of the fistulous opening through the vagina. If these means fail, cure may sometimes be effected by denudation and suturing of the opening from the vaginal side. Should this procedure be unsuccessful, the posterior vaginal wall may be entirely separated from the anterior rectal wall through a perineal incision, care being taken to avoid opening into the peritoneal cavity above. The now freely movable posterior vaginal wall may then be made to slide downward over the anterior wall of the rectum, so that the upper border of the vaginal opening will be below the lower border of the rectal opening, this position being maintained by appropriate suturing. This operation was devised and successfully executed by Paul Segond of Paris.

Fistulæ in the lower portion of the vagina may be denuded and sutured from the vaginal side in the usual manner. Additional sutures may be applied from the rectal side after dilatation of the sphincter ani. Union is often prevented, however, by the disturbing movements of the adjoining sphincters. Under these circumstances, the remaining perineal tissue should be divided by a median incision, and the resulting condition, which is virtually a complete laceration of the perineum, treated according to the methods advised in the consideration of that subject. Fistulæ in this locality are frequently of syphilitic or tubercular origin, and demand preliminary constitutional and local treatment.

Enterovaginal Fistula.—This term includes all fistulæ between the bowel above the rectum, and the vagina. Puerperal rupture of the posterior vaginal cul-de-sac, followed by descent and sloughing of a loop of intestine, direct trauma, operation wounds such as those made in vaginal hysterectomy, and extension of carcinoma with perforation, etc., are the usual causes. The *symptoms* are the escape of feces, and especially of gas, into the vagina through the posterior cul-de-sac.

If the *treatment* by douches and packing, as advised for high rectovaginal fistula, is unsuccessful, the abdomen should be opened, all adhesions loosened, and the opening in the bowel closed in the usual manner. The vaginal opening should not be sutured, but should be packed with gauze.

Enterovesical Fistula.—Fistulous communication between the intestines and bladder may be established as a result of ischiorectal or appendicular abscess; of pressure of foreign bodies, such as pessaries; or of operative procedures, especially vaginal hysterectomy. They are of relatively rare occurrence. The *symptoms* are passage of flatus and feces through the urethra, and cystitis, or other symptoms due to infection from fecal matter. The *diagnosis* is simple, and is usually made clear by passage of gas and fecal matter from the urethra. It has also been made by inflating the rectum with hydrogen gas, which forces its way into the bladder, and, passing down the urethra, may be ignited at the end of a catheter inserted therein. The cystoscope and vesical searcher are of value in determining the exact location of this variety of fistula.

The *treatment* depends upon the situation of the fistula. When, as may occur after vaginal hysterectomy, a rectovesical fistula results, the obliterated portion of the vagina may be reopened by careful dissection, and the resultant vesicovaginal and rectovaginal fistulæ treated separately, in accordance with the rules laid down for the treatment of these conditions.

When, as most frequently happens, the communication between the bladder and intestine is located above the rectum, a similar procedure should be employed, the intestine and bladder separated through an abdominal incision, and the fistulous openings separately closed, care being taken to provide against leakage by careful suturing and by abdominal or vaginal drainage.

44

ECTOPIC GESTATION.

When an impregnated ovum becomes fixed and begins to develop outside of the uterine cavity, ectopic gestation, or extra-uterine pregnancy, is established.

The varieties of ectopic gestation are tubal, ovarian, and abdominal. The terms primary and secondary, in this connection, refer to the condition before and after rupture or change of location of the ovum. Cases of primary ovarian and abdominal gestation are so rare that it may be said that every ectopic gestation is primarily tubal.

Tubal pregnancy may be interstitial, or tubo-uterine; true tubal, isthmial or ampullar; or infundibular, or tubo-ovarian, according to the site of attachment of the ovum.

In *interstitial pregnancy* the ovum develops in the tube where it

FIG. 384.—Ectopic gestation in blind accessory fimbriated extremity of the right tube.

passes through the wall of the uterus, or in a diverticulum from that part of the tube.

In *true tubal pregnancy* the ovum develops in the free portion of the tube, protruding neither into the uterine nor into the abdominal cavity. When pregnancy occurs in the inner portion of the free tube, it is termed *isthmial;* when in the outer portion, *ampullar.*

In *infundibular pregnancy* the ovum is lodged and develops in the infundibulum of the tube, and prevents closure of its abdominal ostium. When, in cases of this variety, the ovum is attached to the ovary, the condition is known as *tubo-ovarian pregnancy.*

Ovarian and *abdominal pregnancy* are terms applied to ectopic gestation supposed to originate and develop in the ovary or abdominal cavity.

Anomalous Varieties.—Ectopic pregnancy in an accessory fimbriated extremity or in a diverticulum from the Fallopian tube is, to all intents and purposes, tubal pregnancy (Figs. 384–386).

Cornual Pregnancy.—Gestation in the undeveloped horn of a bicornuate uterus, due to unequal development or lack of proper union of the Müllerian ducts, is called cornual pregnancy. It is, however, not an extra-uterine pregnancy, but a true uterine pregnancy, which, by malformation of the uterus, has become pedunculated and walled off from the main uterine cavity.

The *secondary forms* of extra-uterine gestation are simply complications of the primary varieties just described. The various names applied to these forms are in such common use, however, that they cannot be ignored.

Etiology.—The point at which the spermatozoa meet and impreg-
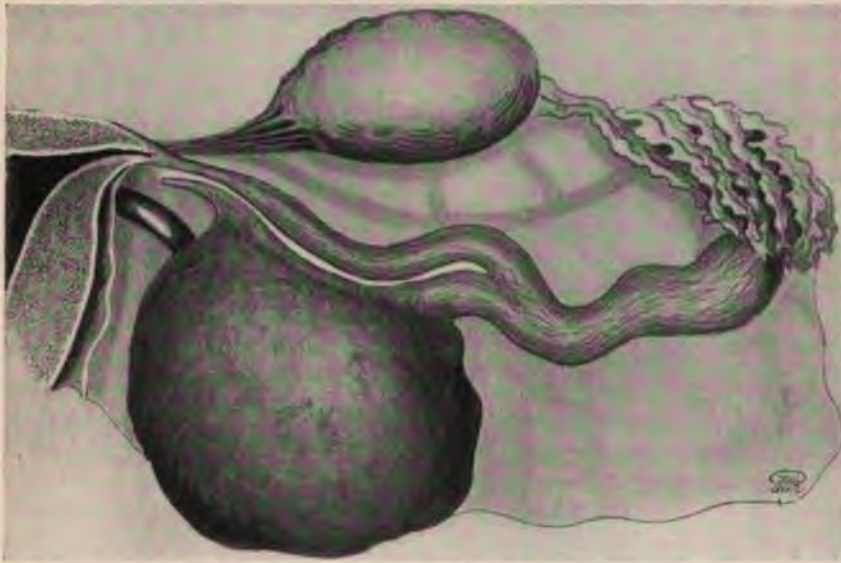
Fig. 385.—Left Fallopian tube, with ectopic gestation in diverticulum.

nate the ovum is not known. The ease with which spermatozoa pass from the vagina through a virgin os uteri into the uterus, and the occasional cases in which they travel through an almost imperforate hymen, make it reasonable to suppose that they may pass as readily up the uterus into the Fallopian tube, and even into the abdominal cavity.

Pathological conditions of the ovum may favor its adhesion to the wall of the tube. Pathological or abnormal conditions of the tube, however, form the most important factor in the causation of ectopic gestation. Chief among these conditions are congenital deviations from the normal type, such as exaggerated convolutions (Fig. 387), diverticula, and atresias; sagging and attachments by adhesions, resulting in distortion of the tube; pressure from adjoining organs; thickening of tubal walls, either congenital or acquired, diminishing peristalsis; des-

FIG. 386.—Sections made from case represented in Fig. 385, on each side and at extremity of diverticulum, showing separate canals and narrowing of diverticulum as it approaches the uterus.

FIG. 387.—Infundibular ectopic gestation, with Fallopian tube showing exaggerated convolutions.

quamative salpingitis or hyperplasia, destroying the cilia or producing atresia; growths either in the canal or the walls, and obscure conditions preventing coaptation of the fimbriæ with the ovum or ovary.

Pathology.—Changes in the Uterus.—With the establishment of pregnancy in the tube the uterus begins to enlarge, and up to the fifth month is usually about one-third smaller than in an intra-uterine pregnancy of the same age. Rupture of a tubal pregnancy, with death of the ovum, checks uterine growth, and involution follows. If the ovum does not die, the uterus may continue to enlarge, but to a lesser degree than before rupture. At full term the uterus of an extra-uterine pregnancy is from 4 to 6 inches in depth. The more remote the place of implantation of the ovum from the uterus, the less the increase in size of that organ.

Decidua.—The formation of a decidua is one of the most notable changes in the uterus in ectopic gestation. It resembles the decidua vera of normal pregnancy, and is thrown off in one complete cast or as débris about the time of primary tubal rupture, and this event is frequently accompanied by metrorrhagia. The membrane is cast off even if the ovum remains alive. The decidua is from $\frac{1}{8}$ to $\frac{1}{4}$ inch thick, rough on its uterine and smooth upon its inner surface, and shows no traces of decidua reflexa nor of decidua serotina.

Alterations and Changes in Tube and Ovum.—These vary with the location of the gestation-sac; but swelling and turgescence are present from the beginning. The thickening consists first of enlargement of the caliber of vessels, then of hypertrophy of the muscularis, similar to the uterine changes that take place in normal pregnancy. This is followed by free development of connective tissue, and often by disappearance of muscular fibers, particularly after minute rupture, which disintegrates and breaks them up by small extravasations, giving rise to inflammatory and cystic changes. Pressure-atrophy of the wall may also take place opposite the placental attachment.

Closure of the ostium abdominale usually occurs about the seventh or eighth week, when the oösperm is retained in the middle or inner portion. Complete closure does not occur when it is retained near the abdominal opening, and there is consequently a tendency to tubal abortion. A decidua is unquestionably formed in the pregnant tube (Fig. 388). It is also occasionally found in the opposite non-pregnant tube. The amount of decidua vera varies in different cases, but it always shows the characteristics of the true decidua of uterine pregnancy; namely, a superficial compact and a spongy lower layer.

A **tubal mole** is due to an arrest of development of the ovum. The circulation is cut off by chorionic hemorrhage, and the ovum is partially or totally detached. It either remains *in situ* and is absorbed; or after detachment, particularly when located in the outer third of the tube, it may be expelled through a patent abdominal ostium into the abdominal cavity, constituting a *tubal abortion*. Sometimes, however, the tube ruptures, and the mole is extruded into the free cavity, with most appalling symptoms.

A tubal mole is round or ovoid, from 2 to 6 cm. (0.8 to 2.4 inches) in diameter, and resembles a blood-clot in color and consistence. On section, it presents a smooth-walled cavity lined with amnion, occa-

sionally containing fetal remnants. Both of these may be absent, but the presence of chorionic villi determines the origin. A tubal mole "is due to blood extravasated from the circulation of the embryo into the subchorionic chamber" (J. Bland Sutton).

Changes in the Placenta.—Decidual membrane is always formed in the tube in tubal pregnancy. The placenta, as in uterine pregnancy, is composed of loosely held masses of chorionic villi, with intervillous blood-spaces bounded externally by varying areas of decidua serotina. Its development is modified by the amount of decidua present, by the narrow available space, by the rugosities of the mucosa, and by the
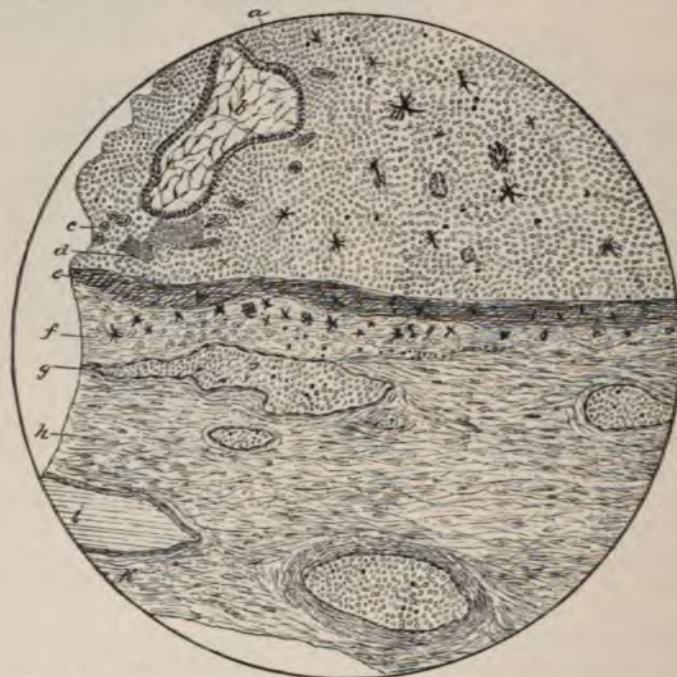
FIG. 388.—Section through wall of pregnant tube and blood-coagulum: *a*, intervillous space; *b*, villus; *c*, syncytial buds; *d*, island of decidual cells; *e*, canalized fibrin; *f*, decidua; *g*, maternal blood-sinus; *h*, fibers of connective and muscular tissue; *i*, gland-space; *k*, artery. Hematoidin crystals and granules are seen in the decidua, in the canalized fibrin, and in the intervillous space.

mobility of the tube. When rupture occurs, if the ovum survives the placenta becomes attached to neighboring structures and continues to grow. The size of the placenta varies directly with the vascularity of the structures upon which it is implanted and with the permanence of the attachment. The essential element of disturbance in its development is traumatic hemorrhage. Early in pregnancy the tube-wall cannot accommodate itself to the growing ovum. It becomes attenuated, and ruptures take place into the substance of the serotina, accompanied by hemorrhages into the intervillous space, endangering the integrity of the villi and chorion (Max Herzog).

Hemorrhages are rarely absent in an ectopic placenta. When the

mass is confined within the tube, the hemorrhages are small; but after rupture they may be severe, or even fatal. The fatal hemorrhages are ordinarily, however, from the maternal vessels, and are consequent upon the detachment of the placenta.

Extravasations also constantly recur into the serotinal tissue, materially increase the bulk of the placenta, and produce an apparent disproportion between its size and that of the ovum. This disproportion has led to the erroneous belief that the placenta continues to grow after the death of the ovum. The chorionic villi degenerate and become mere phantoms with indistinct outlines. New formation of villi is most improbable. The decidua serotina undergoes rapid degeneration. Therefore, after fetal death, increase in size of the placenta is due not to growth of the organ, but to traumatic hemorrhages, which transform it from an oval or round disk to a more or less globular mass, composed of blood-clots in various degrees of organization.

Symptomatology and Diagnosis.—Prior to the fourth month, the cardinal and constant points in the diagnosis of extra-uterine pregnancy are disturbance of menstruation; sharp pelvic pains, usually attended by faintness; and the presence of a mass adjacent to and connected with the uterus. Certainty of diagnosis is based upon a logical analysis of these three factors.

Disturbance of Menstruation. — Menstruation is almost always retarded; but the variations as regards the amount, character, and periodicity are so numerous as to render the description of a typical case difficult. Hemorrhages occurring early in ectopic gestation usually indicate shedding of the decidua.

Pelvic Pain.—The pain is either recurrent and contractile, due to uterine contractions, or sharp and tearing, accompanied by faintness, which indicates rupture to a greater or less degree. Excruciating pain with syncope usually means serious rupture.

Presence of a Mass.—A well-defined movable mass contiguous to the uterus can be felt when an unruptured pregnancy is located at the middle or at the outer end of a normally situated tube. When the tube is prolapsed posteriorly, the mass is felt posterior to the body of the uterus. After rupture into the broad ligament, the mass is felt lateral to the uterus, but lower, not so well outlined, and less movable. When sepsis has supervened, the presence of exudate may render the outlining of the mass more difficult. In interstitial pregnancy, the mass appears as an irregular bulging at the cornu of the uterus. After early rupture into the general peritoneal cavity, no mass may be felt.

When nausea, changes in the breasts, and discoloration of the vaginal mucosa are combined with the signs just mentioned, they constitute strongly presumptive evidence of extra-uterine pregnancy. Corroborative evidence is furnished by the changes in the uterus and by uterine hemorrhage when it occurs. The absence of chorionic villi furnishes another link in the chain of evidence. Exploration of the uterine cavity is now warrantable. When, after careful sounding of the uterine cavity, the uterus is adjudged empty, the diagnosis of early ectopic pregnancy is practically established.

Primary Intraperitoneal Rupture—Hematocele.—Gravid Fallopian tubes usually rupture prior to the fourth month. Primary rupture may

be intraperitoneal or extraperitoneal. Primary intraperitoneal ruptures generally occur prior to the seventh week, and so frequently in the fifth or sixth week after menstruation that pregnancy is not suspected. Women with pre-existing pelvic disease are especially prone to extra-uterine pregnancy; hence menstrual irregularities pass unnoticed (Figs. 389, 390).

The diagnosis of primary intraperitoneal rupture prior to the seventh week is the diagnosis of intra-abdominal hemorrhage. Failure to recognize a tumor near the uterus is not very important. Thorough

FIG. 389.—Primary intraperitoneal rupture, fifth week; ovum still adherent to its original site. Complete rupture of the tube.

FIG. 390.—Very early tubal pregnancy (two to three weeks), with rupture.

examination is difficult on account of the condition of the patient. The chief reliance must be placed upon the general conditions of shock and collapse, as the presence of blood can seldom be demonstrated by fluctuation, abdominal palpation, or bimanual examination, even when the hemorrhage is enormous. Exquisite general abdominal tenderness is, however, a symptom rarely absent. The ovum may be so small as to produce no appreciable enlargement; or it may have been expelled into the general peritoneal cavity.

Primary Extraperitoneal Rupture—Hematoma of the Broad Liga-

ment.—An extra-uterine pregnancy may grow downward and cleave the folds of the broad ligament without rupture of the tube proper, the adjoining portions of the broad ligament gradually stretching to accommodate the growing ovum. As a rule, rupture occurs between the seventh and twelfth weeks of pregnancy, and is indicated by an increase in pain, and faintness. The signs before rupture are often not sufficiently marked to denote the character of the pregnancy, and the patient believes herself normally pregnant. The pain in this variety is recurrent and paroxysmal, varies greatly in severity and duration, and each attack probably indicates an extension of the rupture. The collapse is not so extreme as in intraperitoneal rupture, because the effused blood is limited by the resistance of the adjoining structures. Early cases of this variety are often not diagnosed. The ovum and secundines are gradually absorbed and the patient is never very ill; but when rupture occurs after the seventh week, severe illness generally ensues. Even up to ten or twelve weeks the rupture may have taken place so evenly and slowly that the patient does not seek medical advice until the appearance of constitutional symptoms indicative of sepsis.

In the great majority of cases the ovum dies at the time of rupture. The traumatism, however, leads to the formation of protective exudate, which materially increases the size of the whole mass. This increase gives rise to pronounced pain, and sooner or later in almost all cases sepsis supervenes, attended by the usual constitutional evidence.

Secondary Rupture.—This term applies only to the extraperitoneal variety, in which the ovum, after forcing its way below the peritoneum in the folds of the broad ligament, ruptures into the general peritoneal cavity. Secondary rupture may be due to various causes. After primary rupture the ovum may survive, and its continued growth may result in communication with the general cavity. The rupture is sometimes sudden, and the effusion of blood may be so extensive as to give rise to most serious symptoms, with fatal results. The appearances resemble those of early primary rupture, and the treatment must be equally prompt.

Secondary rupture may follow primary rupture so closely that they can hardly be differentiated. In other cases, the ovum surviving, the secondary rupture may be slow and not extensive, the opening may be reinforced by quickly formed exudate, and the symptoms may be more subdued. Such accidents may recur repeatedly, and, if the ovum survives, the so-called advanced abdominal extra-uterine pregnancy is developed.

Interstitial, or tubo-uterine, and infundibular, or tubo-ovarian, gestation are especially prone to early primary intraperitoneal rupture. In true tubal pregnancy, extraperitoneal rupture is more likely to occur when the placenta is implanted on the superior inner surface of the tube. When, on the other hand, it is implanted on the lower inner surface, the upper part of the tube becomes thin, and early rupture into the general peritoneal cavity is most probable. Almost all of the cases of extraperitoneal rupture occur in true tubal gestation.

After the Fourth Month.—*Unruptured Tubal Pregnancy.*—If the ovum survives, new signs become evident, after the fourth month,

which demand separate consideration as regards diagnosis. Few ectopic gestations survive the fourth month; and of these, very few, indeed, have not been subject to either intraperitoneal or extraperitoneal rupture. There can be no doubt, however, that women have passed through extra-uterine pregnancy to term, carrying the child within the dilated tube without appreciable rupture in any direction (Fig. 391).

Abdominal Pregnancy without Rupture.—The existence of this condition is still *sub judice.* Some authorities believe that an impregnated ovum can find its way into the general cavity; or that an ovule can there become impregnated and implanted, and grow even to full term without rupture. Their opponents maintain that all abdominal pregnancies were originally tubal; that rupture took place into the general cavity, but that sufficient attachments to the tubal mucous membrane

FIG. 391.—Unruptured tubal pregnancy, three weeks after spurious labor, showing obliterated vaginal fornix.

remained to nourish the ovum; and that, eventually, although the placenta became universally attached to the surrounding structures, all cases could be traced to the tube as the site of primary implantation. At this date the consensus of opinion inclines to the latter view. (Fig. 392).

In almost all cases of advanced ectopic gestation, the symptoms and signs common to uterine and ectopic gestation are present; namely, disturbance of menstruation, changes in the breasts, enlargement of the uterus, nausea, changes of the vulva, thinning and softening of the lower uterine segment, and mucous vaginal discharges, in addition to the symptoms before detailed as due to rupture in the earlier months.

After the fourth month other signs become manifest, which demand special attention. These are changes in the breasts characteristic of advanced pregnancy, movements of the fetus, and abdominal enlarge-

ment; while careful examination often reveals ballottement and placental souffle.

Changes in the Breasts.—These resemble the changes of uterine pregnancy; but the areola is not so well defined, the breasts so full, nor the secretion so abundant.

Movements of the Fetus.—The perceptibility of these movements differs according to the variety of the case. In so-called abdominal pregnancy, when the patient is reasonably thin, fetal movements are

FIG. 392.—Secondary abdominal pregnancy at eight months, primarily tubal.

often evident to the examiner, even when hardly noticeable to the patient. When near term, with a reasonably vigorous child, movements may be felt and seen so plainly immediately beneath the abdominal wall as to form a valuable diagnostic sign. In the subperitoneal forms, the movements are not so plain, although they closely resemble those of the fetus *in utero;* but they may be very painful to the patient. If the pregnancy advances to the fifth month, the movements of the fetus are thereafter more plainly discernible than are those of a uterine pregnancy of the same age.

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Movements of the Fetus.—The perceptibility of these movements differs according to the variety of the case. In so-called abdominal pregnancy, when the patient is reasonably thin, fetal movements are

FIG. 392.—Secondary abdominal pregnancy at eight months, primarily tubal.

often evident to the examiner, even when hardly noticeable to the patient. When near term, with a reasonably vigorous child, movements may be felt and seen so plainly immediately beneath the abdominal wall as to form a valuable diagnostic sign. In the subperitoneal forms, the movements are not so plain, although they closely resemble those of the fetus *in utero;* but they may be very painful to the patient. If the pregnancy advances to the fifth month, the movements of the fetus are thereafter more plainly discernible than are those of a uterine pregnancy of the same age.

Abdominal Enlargement.—Careful examination of the abdominal enlargement of a suspected extra-uterine gestation is extremely important. The enlargement differs materially from that of normal gestation in that it is not so symmetrical nor so centrally located. In interstitial pregnancy, it may show soon after the third month, but usually slightly to one side. In free tubal and subperitoneal pregnancy, the enlargement is usually observed first on the side affected. It is generally resonant from superimposed intestines, and more or less irregular and nodular. In abdominal pregnancy, the enlargement is still more irregular and nodular; the mass is plainly recognizable and dull on percussion, unless it has become adherent to the intestine. The mass is often wider from side to side, and differs essentially from the smooth ovoid of the normally pregnant uterus.

Bimanual examination of a six or seven months' ectopic gestation will, if the examiner is experienced, throw much light upon the nature of the case. At this stage the uterus can usually be outlined, and a well-marked groove between the uterus and sac made out. Great care, however, must be taken in the differentiation between this condition and a pregnant retroflexed uterus. An important sign in true tubal unruptured pregnancy is the obliteration of the vaginal fornix on the affected side. In case of repeated rupture, in which the abdomen and pelvis are filled with irregular masses matted together by adhesions, and the uterus is adherent to and fused among these masses, the diagnosis is often extremely difficult.

Palpation of the fetus is sometimes easy, on account of the thinness of the overlying tissues; it is frequently rendered difficult, however, by implantation of the placenta upon the anterior wall of the sac. An interstitial sac may retain its central location; but its length will be out of proportion to its breadth. In tubal pregnancy, the uterus will usually be pushed to one side and up behind the pubes, as the sac settles down in Douglas's pouch. If the pregnancy develops low down and adhesions do not form, the uterus may be crowded up so that the cervix can hardly be reached.

Ballottement may be elicited either anterior or posterior to the uterus.

Placental souffle is of significance in only a small proportion of cases. It begins to be heard about the end of the third month, but is often very faint. In secondary rupture, when the placenta spreads out anteriorly just beneath the abdominal wall, it may suggest the character of the case by its intensity and extent.

False or spurious labor supervenes when the fetus has reached term; or it may occur earlier, at the seventh or eighth month. This phenomenon has never been satisfactorily explained. It differs materially in different patients, being sometimes abrupt, consisting of defined contractile pains, gradually increasing in severity, and lasting from a few hours to one or two days; then subsiding, either not to return or to recur several times at irregular intervals.

There is but one true labor, and this follows, or rather causes, the death of the child. Later pains are probably due to inflammatory changes in the gestation-sac or to complications.

Changes after Spurious Labor.—Well-defined spurious labor always

results in death of the fetus, followed by subsidence of the abdominal swelling, involution of the uterus, and moderate lochial discharge. Immediate decrease in the size of the abdomen is not constant, either because of delay in absorption of the liquor amnii, or because of increase in placental bulk, due to hemorrhage from vessels ruptured during the spurious labor or disintegrated by septic changes. Sometimes spurious labor is almost immediately followed by septic symptoms, development of hectic fever, and breaking down of the gestation-sac into a suppurative gangrenous mass. The pus burrows in various directions, and is expelled by way of the bladder, rectum, vagina, or abdominal wall, the disintegrated remains of the fetus following the same channel. Few, if any, advanced cases open into the general peritoneal cavity and prove fatal by a septic peritonitis, because, when the gestation-sac attains a certain size, the pressure and inflammatory changes obliterate the general cavity, and the neighboring structures become adherent to the outer surface of the sac, so that no free cavity remains. This process of maceration, suppuration, and expulsion is fraught with great pain and danger to the patient.

In some cases the fetus and its membranes and the placenta undergo changes without septic symptoms, which result in the abdominal inclusion of the modified fetus, which is now termed *lithopedion*. Mummification, calcification, or adipocere-formation of the ovum or sac, or of both, may also result, the various formations being frequently shown in different locations in the same specimen.

Mummification apparently results from absorption of all the fluid portion of the fetus, and possibly of the sac and placenta. The bones remain more or less intact, and the soft parts resemble dark-brown, shrunken parchment.

Calcification means hardening of all the parts from impregnation with lime salts.

Adipocere-formation is that condition in which the soft parts, and even portions of the bones of the fetus, are converted into a soft, soapy mass. This change is supposed to be due to a combination of the fats and ammonia.

A fetal sac which has undergone these changes may remain *in situ* for thirty, forty, or even fifty years without harm. At any time, however, infection of the sac may occur without apparent cause, attended by all the dangers described as resulting from primary septic infection.

Treatment.—Prior to the Fourth Month.—Surgery is the only treatment of value in ectopic gestation prior to the fourth month, with the exception of the following conditions:

When the patient is moribund, operation is useless.

When the patient is recovering, watchful expectancy may be all that is necessary.

When the diagnosis is obscure, the symptoms may not be sufficiently marked or severe to demand exploratory incision.

Injections of morphin, or the passage of strong electric currents into the gestation-sac, are not advisable, as they do not clear up a doubtful diagnosis, and as the manipulation and interference incident to their thorough application are at least as dangerous as operation.

In no department of surgery have the results been more brilliant,

more perfect, and more life-saving than in the modern surgery of early ectopic gestation.

Before Rupture.—With the exceptions noted above, unruptured ectopic pregnancy prior to the fourth month should always be removed. This is usually best accomplished by median abdominal section, with removal of the affected tube and its contents. The operation is simple. A ligature is placed on either side of the mass, and the latter excised completely, the hemorrhage being checked, if necessary, by ligatures. The cut surfaces are approximated by catgut sutures, thus maintaining the function of the broad ligament in supporting the uterus in position. The application of an overhand continued suture to cover the cut surface and sutures with peritoneum adds to the safety of the patient. If the operation is properly performed, convalescence will be rapid and uncomplicated.

In interstitial pregnancy, incision is made through the muscular layers down to the sac, which is carefully shelled out. The bleeding is checked by buried sutures, and the seat of operation is covered with peritoneum by fine superficial sutures. The abdominal cavity should not be closed until all oozing has ceased.

After Rupture.—Primary Intraperitoneal Rupture.—The treatment of this phase of ectopic gestation is that of intra-abdominal hemorrhage. The responsibility in these cases is immense, and prompt treatment is absolutely necessary to save life. The abdomen must be opened and the bleeding point ligated. The operation should be performed as soon as the diagnosis is established, for such patients are liable to repeated hemorrhages. The uniformity of success following these operations, when the patient is not moribund, is gratifying.

Acute early primary rupture with free abdominal hemorrhage should always be treated by abdominal section and direct ligation. The bowels should be filled with warm normal salt solution; the patient placed in the Trendelenburg position; the field of operation thoroughly cleansed; the incision made quickly; the hand at once passed down through the blood to the point of rupture; a clamp placed on each side of the tear; sufficient blood wiped away to permit the passing of ligatures; the large clots, and possibly the product of conception, removed; the tube exsected; hemostasis secured, and the abdomen immediately closed. The operation can often be completed in fifteen minutes. Continuous infusion of physiological saline solution into the cellular tissue may be made during the operation, if necessary, by an assistant. If septic material is encountered in the abdominal cavity, whether it be exudate around the affected tube, disease of the other tube, or doubtful conditions in the region of the appendix; also, if the operator is not certain of the aseptic character of his manipulations, the abdominal cavity should be thoroughly cleansed and drainage employed through the lower end of the wound or through the vagina. If, however, the patient's condition will not allow prolongation of the operation, a large Mikulicz drain may be introduced.

Great restlessness is a symptom of considerable importance, as it frequently means impending death. If this symptom is not present, no matter how profound the shock, the patient is seldom beyond hope of safety by rapid operation.

Differentiation should be made between recurrent, temporary swoons and profound progressive collapse. It should be remembered that the shorter the time between the beginning of the attack and profound collapse, the more urgent the need of immediate operation.

When asepsis has supposedly been maintained, the blood is left free in the abdominal cavity, because the shorter the operation, the better the prospect of recovery, and the less the manipulation, the less the impairment of the absorptive powers of the peritoneum; and because the absorption of the serum in the cavity into the circulation at once stimulates the patient pending the general revival of vital forces.

The Trendelenburg position is preferable, because the presence of much blood in the pelvis interferes materially with the application of ligatures; because inversion of the patient by gravity forces much of the blood toward the diaphragmatic region, where it is more easily absorbed, and because this position lessens the syncope.

The treatment for primary intraperitoneal rupture of interstitial pregnancy is the same as that just described, excepting that it may not be necessary to exsect the tube, as the cavity left after removal of the ovum is closed by tier sutures. If gestation is well advanced before rupture, the injury to the uterus may necessitate hysterectomy.

Subperitoneal Rupture.—Subject to the exceptions already noted, removal of the gestation-sac is the proper treatment for this class of patients. As the hemorrhage is restricted by the surrounding structures, the symptoms are less acute and alarming, and the shock not so great, although the pain is often much more severe. Although many of these patients may recover without operation, the latter is to be preferred when the patient is seen soon after the rupture, because it eliminates many dangers, saves the patient much pain, and, as a rule, is followed by recovery with perfect physiological function.

Acute non-septic subperitoneal rupture should always be treated by median abdominal section. When the rupture does not occur until the tenth to the fourteenth week, especial care should be taken in opening the abdominal cavity, as adhesions may be present and the contents of the sac septic. The Trendelenburg position materially facilitates the operation. The first step after the opening of the abdomen is to wall off carefully the affected area with aseptic gauze pads, so as to protect the healthy portion of the cavity. If fluctuation is present, this portion of the mass is opened by a very small incision; or a trocar is introduced, and the liquid contents evacuated slowly and caught on large gauze sponges. The mass is then shelled out and the vessels ligated. In easily accessible cases, ligation may first be made. Almost the only source of danger is the loosening of intestinal adhesions. Occasionally, free hemorrhage demands the Mikulicz pelvic tamponade.

Secondary Rupture.—The treatment is similar to that of primary rupture, but the contents of the sac are liable to be septic. The patient should therefore not be placed in the Trendelenburg position until the abdomen has been opened, the parts well isolated, and the peritoneal cavity cleansed, as far as the patient's condition will allow.

Septic Cases and Vaginal Incision.—When a patient has passed safely through the first stage of rupture without operation, she fre-

quently suffers from various complications the results of sepsis. She may die in a few days from general diffuse peritonitis. It is difficult to decide whether or not to operate in this condition. If the symptoms are not very acute and the rupture is very early, it may be more advisable to trust to nature and intelligent medical treatment. If the rupture is late and the symptoms severe, abdominal incision would better be employed, and the cavity carefully cleansed with warm normal salt solution, if it seems impossible to cleanse it properly with gauze, after which drainage through the lower angle of the abdominal wound or through a vaginal opening posterior to the cervix, or both, should be instituted.

If the septic mass is situated low down in the pelvis, vaginal incision with drainage is often the most desirable operation, as it is generally followed by the happiest results.

After the Fourth Month.—After ectopic gestation has advanced into and beyond the fifth month, various considerations of importance which bear directly upon the safety of the mother demand recognition, and call for most careful judgment on the part of the surgeon. The development of the sac, increase in size of the blood-vessels, development of the placenta, and probable presence of adhesions, all combine to increase materially the danger of interference.

In cases at or near term, the life of the child is an important consideration. No definite rule can be laid down as regards interference while the child is living. It is justly held by most surgeons that the life of the child should be held subordinate to that of the mother.

The question of operating at the eighth month, with the intention of saving the life of the mother and child, or of waiting until spurious labor has occurred, is most perplexing; but the surgeon may be aided in reaching a conclusion by peculiarities or conditions in individual cases.

When a woman is so reduced by repeated attacks of circumscribed peritonitis, recurrent moderate hemorrhages, and excessive pain that she can neither endure operation nor continue in her present condition, the proper treatment is to insert a hypodermic needle deeply into some prominent fetal part under aseptic precautions, and inject ½ grain of morphin; this will kill the child, but will not harm the mother. When the child dies, placental souffle will disappear, pain will subside, part of the liquor amnii will be absorbed, dyspnea will lessen, hemorrhage will not recur, and after three or four weeks an operation can be safely performed.

When a woman of strength and good health has an extra-uterine gestation, with the child presenting favorably and a placenta that can apparently be easily avoided, endeavor should be made to save the child.

Surgical interference is necessary in almost all cases of advanced ectopic gestation; and in these cases the diagnosis is not usually obscure.

The object of all operations on ectopic gestation is the removal of the gestation-sac, including the affected tube. In advanced cases this is often impossible; but as the fetus comprises the most offending part of the gestation, it should always be removed.

Avoidance of the placental site is of the utmost importance in these

operations, because of the danger of hemorrhage. The most favorable time to operate is two or three weeks after the death of the child, but before definite signs of sepsis appear. Because of the liability to hemorrhage, all operations must be performed quickly and the parts brought well into view; therefore, in aseptic cases, when the child is supposedly alive, abdominal section is almost always the operation of choice.

Ordinarily, the vaginal incision will prove available only for those cases in which sepsis is well developed and in which the gestation-sac is filled with putrid material and a decomposed fetus, and so presents in the vagina as to form a clear indication.

The abdominal incision need not be median. The surgical sense of the operator must indicate the incision by which the fetus can best be reached and the placenta avoided.

When the Fetus is in the Unruptured Tube.—In infundibular gestation, it is doubtful whether the fetus can so develop as to be included in the category of advanced unruptured tubal pregnancy. Almost all cases, therefore, must be ampullar or interstitial. In the latter variety, the uterus has been dilated, its fundus incised, and the child extracted. The proper and reasonable treatment is, however, abdominal section over the most prominent portion of the tumor, usually near the median line and low down. As the external layer of the sac is frequently adherent to the anterior abdominal wall, the sac is often opened freely without entering or perceiving the free abdominal cavity. The placental sac should be avoided by careful auscultation before the operation, and by deviation of the inner incision if possible. When the sac is opened, the child is at once extracted and passed to an assistant; another assistant during this time compresses the broad ligaments at each side of the sac.

The extraction of the placenta and its management are exceedingly important steps in the operation. If it is conveniently situated, it may be rapidly shelled out, and the hemorrhage controlled by firm gauze packing. If it is deeply attached, and the large lower vessels are inaccessible because of adhesions, the placenta may be left in place and a firm gauze tampon applied for hemostasis. If the child has been dead for a few days, the placenta may be removed with only slight risk; but no attempt should be made to remove the sac. If the sac or uterus, or both, have been extensively lacerated, and hemorrhage is apparently uncontrollable, it is better to remove both uterus and sac.

The edges of the incision in the sac should be united to the edges of the abdominal wound, and the cavity packed with gauze, whether the placenta is removed or left *in situ.* In the latter case the placenta can usually be removed after a few days with slight risk. If sepsis occurs, however, immediate removal becomes imperative.

When the Fetus is in the Abdominal Cavity.—Removal of the sac and placenta in this variety is extremely difficult, tedious, and dangerous. After the abdomen is opened, the sac is incised at a place where the vessels are least numerous, and the child is extracted. The placenta is not removed unless sepsis is present. The sac is carefully packed with gauze strips, which protrude from the lower angle of the wound. If possible, the sac wound is united to the abdominal wound, the rest of the incision being closed, excepting at the lower angle. Some of the stitches may be removed in a few days, and the placenta

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extracted, the sac being carefully repacked. If practicable, the ovarian artery should be ligated on both sides of the mass.

The abdomen should be bandaged tightly, with the exception of the point of drainage, as removal of pressure may provoke hemorrhage.

If the child is small and presents low down in the pelvis, it may in rare instances be extracted with more ease through a vaginal incision.

When the Fetus is Subperitoneal.—The treatment of this condition differs in only two particulars from that described above. As the peritoneum is pushed upward and toward the unaffected side, the incision must be low and often oblique, so as to reach the sac without opening the general cavity. The mass cannot be removed, because the membranes and peritoneum are so fused as usually to obliterate even the semblance of a sac.

These operations are often extremely hazardous ; and it should be borne in mind that removal of the fetus is the primary object of interference.

When the fetus is dead and suppuration has occurred, the sac should be opened, its contents removed, and drainage established.

If the fetus is much macerated and pus has found its way into the bladder, the latter may be opened from the vagina and the child extracted piecemeal. If the same accident has occurred by way of the rectum, the anus may be dilated and delivery assisted by that route.

When a patient with ectopic gestation comes under observation after the fetus has undergone mummification, calcification, or adipocere-formation, the operative indications already presented as applying to a recently dead fetus will suffice.

Repeated Ectopic Gestation.—Many instances are recorded in which, after removal of one tube for ectopic gestation, impregnation has occurred in the remaining tube. Several cases have also been reported in which two, or even three, gestations have occurred in the same tube. Uterine pregnancy in the presence of a retained extra-uterine fetus has been frequently noted.

Twin Ectopic Gestation.—It has been claimed that twin pregnancies may occur outside of the uterus ; but the cases are infrequent, and, as a rule, so imperfectly described that their validity is questionable.

Concurrent ectopic and uterine gestation may progress equally even to term, or either fetus may prematurely die. In advanced pregnancy, the treatment of such cases presents most formidable complications. There is no recorded instance of operation in such cases, when both children were alive and near term, in which the mother survived.

Under these circumstances, one of the two following courses may be followed : As soon as the diagnosis has been established, the extra-uterine fetus may be sacrificed by an injection of morphin into its body, as described above. Ten days later, or at the first indication of sepsis, uterine contractions may be carefully brought on, and a reasonable chance for life may thereby be given to the uterine child and the mother. The extra-uterine fetus can be dealt with later, according to indications. If interference becomes necessary soon after delivery, the second operation would be more likely to be successful, because of the elimination of abdominal hemorrhage, the predominant danger in such cases.

Labor may be carefully induced, and the ectopic gestation ignored and treated independently at a later period.

An advanced living ectopic gestation should never be operated upon in the presence of a concurrent living uterine pregnancy.

Cornual Gestation.—When pregnancy occurs in a horn of a bicornuate uterus, the pregnancy may result in normal delivery if the horn is well developed. If, however, the horn is rudimentary and does not communicate freely with the lower genital tract, it is to all intents and purposes an ectopic gestation, presents the same signs, and requires similar treatment.

Utero-abdominal or Traumatic Ectopic Gestation.—A preg-

FIG. 393.—Utero-abdominal or traumatic ectopic gestation.

nant uterus may rupture, and the fetus may escape and develop in the abdominal cavity, the placenta remaining sufficiently attached to nourish the child. Leopold has reported a case of this kind operated upon at term. The writer observed the following case in 1895 : A patient, when seven weeks pregnant, introduced a sharp instrument into the uterus to induce abortion. After two and a half months of intermittent pain, with subacute septic symptoms, operation was performed, when the fetal sac was found still intact in the free abdominal cavity, where it had continued to develop after the injury which caused its expulsion from the uterus (Fig. 393). The placenta was still adherent to its original site, but had become attached to the tear in the uterus and to the adjoining external uterine surface.

DISEASES OF THE FEMALE BLADDER.

Diseases of the female bladder differ from those of the male bladder (described in Chapter XVII.) only in the peculiarities incident to its anatomical relations. The shortness of the female urethra and the exposed location of its external orifice makes the bladder especially prone to both infection and irritation from the introduction of foreign bodies.

Cystitis.—Cystitis, or inflammation of the bladder, is due to the active invasion of the walls of the bladder by pathogenic microbes. The presence of microbes in the urine is not in itself an indication of cystitis; nor does cystitis necessarily result from the presence of microbes in the urine. Various micro-organisms may be injected experimentally into the normal bladder without exciting inflammation; and microbes are frequently eliminated from the body through the urine without harm to the bladder. An abscess may even rupture and evacuate itself into the bladder without resultant inflammation. The presence of microbes is not only necessary, but, in order to produce inflammation, they must invade the tissues.

The **etiology** of cystitis in the female may be considered under three heads: (*a*) Conditions which favor the lodgement and development of the micro-organisms; (*b*) the manner and route by which the microbes gain access to the bladder; (*c*) the variety of microbes present.

Hyperemia and *congestion* deserve first mention among the conditions that favor microbic invasion. These conditions may be produced by a variety of causes. The bladder mucosa is always more or less hyperemic during the menstrual period and the activity of the pelvic organs incident to pregnancy, excessive coitus, and masturbation.

Tumors of the uterus or other pelvic structures, contiguous inflammation, prolonged retention of urine, and exposure to cold may also produce hyperemia or congestion of the bladder. Abnormal states of the urine, such as great concentration or a high degree of acidity; toxic agents from general infectious diseases, or toxic substances, such as alcohol, cantharides, or turpentine administered by the mouth; or such articles of food as asparagus, parsley, rhubarb, etc., may also affect the bladder mucosa. Traumata of the bladder produced by prolonged or difficult labor, the obstetric forceps, vaginal operations, catheterization, vesical instrumentation, introduction of foreign bodies by the patient, vesical calculi, fracture of pelvis, gunshot wounds, etc., not only cause hyperemia of the bladder, but furnish atria for the lodgement and development of micro-organisms. Obstructions to the escape of urine, due to urethral stricture, compression or displacement from tumors, may cause distention and hyperemia of the bladder.

To the above-mentioned predisposing causes must be added pathogenic microbes before inflammation actually exists. Microbes may gain access to the bladder: (*a*) Through the urethra; (*b*) from the kidneys, descending with the urine; (*c*) from contiguous tissues; and (*d*) from the blood.

The urethra is unquestionably the most common route. Microbes may be introduced into the bladder on an unclean catheter, or a clean catheter may become contaminated by the microbes which are always present about the meatus and vestibule. A catheter may thus act as a predisposing cause by producing slight trauma or congestion of the bladder-wall, and also as a direct carrier of micro-organisms.

Microbes may also reach the bladder by simple extension along the urethra. This is particularly true of the gonococcus. Foreign bodies introduced into the bladder by the

patient when masturbating may also act as germ-carriers. In the acute infective diseases, typhoid fever, pneumonia, etc., microbes are almost constantly being eliminated by the kidneys, and, passing down to the bladder with the urine, may occasionally find lodgement and develop ; or the microbes may lodge primarily in the kidney and produce a focus from which the bladder is secondarily infected. This is perhaps more common with the tubercle bacillus. An adjoining pyosalpinx or a parametritis or perimetritic septic focus may infect the bladder by migration of microbes through the intervening wall or by rupture of the abscess into the bladder. A loop of bowel may also become adherent to the bladder and permit migration of microbes into the latter. While a hematogenous infection of the bladder is possible, it is the least common form of the disease.

A great variety of micro-organisms have been found in the bladder in cystitis. Those most commonly observed are : Bacillus coli communis; Staphylococcus pyogenes aureus, albus, and citreus ; Streptococcus pyogenes ; gonococcus, and tubercle bacillus.

Other varieties, such as the Bacillus lactis aërogenes, Urobacillus liquefaciens, typhoid bacillus, Bacillus aërogenes capsulatus, and the proteus, have occasionally been found. In chronic cystitis it is not uncommon to find a mixed infection.

The **hyperemia of the bladder** produced by any of the before-mentioned conditions is not usually distributed over the entire surface of the bladder, but is somewhat limited in extent. The trigonum is the part most frequently involved, and the hyperemic patches may be still further limited to one or more small areas about the internal urethral orifice, or to a small area around one or both ureteral orifices. When viewed through the vesical speculum or cystoscope, the hyperemic area appears of a deep rose color, and somewhat edematous or thicker than the surrounding normal mucosa. This is the condition in earlier days so frequently described under the title of "irritable bladder." It is attended by a frequent desire to urinate, and at times by a slight burning sensation. Occasionally the patient is not relieved after urinating, but is troubled with a distressing pressure about the neck of the bladder, which may persist from a few minutes to an hour. These patients often are, or become, very nervous, hysterical, or neurasthenic. The urine is clear and usually normal, with the exception of hyperacidity at times.

Treatment of Hyperemia.—This condition is best relieved by the removal, if possible, of the cause of the hyperemia, careful attention to the general health and to the composition of the urine, and by making local applications every few days to the hyperemic areas of a 2 or 3 per cent. solution of silver nitrate, under direct inspection through a vesical speculum.

When the bladder becomes infected and cystitis develops, the conditions are much more aggravated. The vesical walls are thickened, and the mucosa is deeply injected, dark red, and very sensitive both to direct contact and to indirect pressure between the examining fingers. If the infection is due to the Bacillus tuberculosis, small, round or oval, glistening elevations, or papules, may at times be seen on the trigonum or around the ureteral orifices. When these soften and break down, small ulcers are formed. Ulcers of the vesical mucosa are almost invariably tuberculous. They can, as a rule, easily be seen through the vesical speculum or cystoscope ; and this direct inspection should never be omitted in any case of suspected tubercular vesical disease. Small portions of an ulcer or of an inflamed surface may be removed by the curet through the speculum, and submitted to microscopical examination for diagnostic purposes.

Symptoms of Cystitis.—Cystitis in the female, for anatomical rea-

sons, is more amenable to treatment than in the male. It may occur at any age, but is most frequently met with during the child-bearing period and old age. It manifests its presence by pain, frequent urination, pyuria, and ammoniacal or decomposed urine. None of these symptoms or signs alone is indicative of cystitis; but they must all be present, with the exception, occasionally, of ammoniacal or decomposed urine, which will be mentioned later.

The pain is referred by the patient to the region of the bladder or the urethra, and is described as a burning or smarting sensation, or a feeling of weight or fulness. As the urine accumulates in the bladder this sensation of pain increases until the desire to urinate becomes imperative, and relief is sought by evacuating the bladder. The relief, however, is often not marked nor of long duration; and the patient is tormented by a constant desire to urinate, and is obliged to empty the bladder every hour or two, or even every five to ten minutes, day and night. By reason of the great loss and disturbance of rest, the appetite fails, and the general health and strength suffer greatly.

Upon examination, the urine is found to contain pus, the amount of which varies greatly with the duration and severity of the affection, and with the kind of infection, from a slight cloudiness to one-fourth, or even one-half, of the bulk of urine when allowed to settle in a test-tube. In addition to the pus, when the urine is examined under the microscope, numerous flat and transitional epithelial cells from the bladder, blood-cells, triple-phosphate crystals of decomposition, and bacteria are found. The urine undergoes ammoniacal decomposition within the bladder in all severe cases of long standing, excepting when the disease is due to tuberculous infection, in which case the urine may retain its normal acid reaction, even when ulceration is present with marked local and general disturbances, until some mixed infection takes place.

In the **diagnosis of cystitis**, it is not sufficient to know that the patient urinates frequently and has pus in the urine; but it must be determined absolutely that the pus originates in the bladder. This may require, at times, that urine be obtained directly from the kidneys by catheterization of the ureters. This procedure carries with it the responsibility of infecting the kidneys, but may be avoided by the employment of the urine-segregator devised by Harris. The cystoscope or the Kelly method of inspecting the interior of the bladder should always be used, in order to obtain exact information regarding the condition of the vesical mucosa. Microscopical and bacteriological examination of the urine should be made to determine the nature of the infection.

In the **treatment of cystitis**, the etiological factors should always be kept prominently in view, as the bladder has great recuperative power when the cause of the inflammation has been determined and removed.

The bladder must be relieved from the pressure and displacement caused by an ovarian or uterine tumor. A contiguous pyosalpinx or peri-uterine or para-uterine abscess must be removed or evacuated and drained. If a loop of intestine be adherent, it must be released. A focus of infection from the kidney, which would constantly reinfect the bladder, must be removed by operation or otherwise. Gonorrheal infection of the urethra and vestibular glands should receive proper treatment.

Abnormal states of the urine dependent upon the general condition should be corrected.

When all these etiological and predisposing factors have received proper care, attention may be directed to the bladder. When the condition is severe, the patient should be confined to bed, and the necessary amount of rest secured by anodynes, if required. The appetite should be encouraged and the diet regulated. Free use of milk and liquids is beneficial. Remedies which exert a soothing influence on the bladder when eliminated with the urine, or which prevent decomposition of the urine in the bladder, may be administered. Fluid extract of stigmata maidis, oleum santali, salol, boric acid, and urotropin are among the best of these remedies.

Local treatment is of the greatest importance. Daily irrigation of the bladder with warm 3 per cent. boric-acid solution or 1 : 5000 bichlorid solution may be made. The author has observed excellent results from the use of 1 : 2000 or 1 : 1000 formalin (40 per cent.) in normal salt solution, even in tuberculous cases.

When ulceration exists, direct application of a 3 to 5 per cent. silvernitrate solution may be made through the speculum, or the ulcers may be curetted and 10 per cent. iodoform emulsion in glycerin applied.

Should the patient, after persistent and thorough treatment, still remain unrelieved, permanent drainage of the bladder may be instituted, either through a vaginal or a suprapubic incision. This places the bladder completely at rest, and is often followed by cure. The fistula may then be closed and the bladder functions restored.

Vesical Calculus.—Vesical calculi are very rarely met. with in women. Ultzmann gives the proportion of frequency as 1 in the female to 200 in the male.

Calculi are produced by the various normal or pathological constituents in the urine gradually depositing about a central point or nucleus. *Primary* calculi, so-called because they may develop in otherwise healthy bladders, are composed of the normal salts of the urine, such as urea, uric acid, urates, oxalate of lime, etc. *Secondary* calculi, so called because they develop only in septic bladders, are composed of the decomposition-phosphates.

A calculus may originate in the kidney and migrate to the bladder, and there continue to enlarge; or it may originate in the bladder. The former variety is of extremely rare occurrence in the female, as a calculus which could pass through the ureter would almost certainly pass at once out through the urethra unless some pathological condition, such as stricture of the urethra, swelling or rigidity of the urethral walls, paralysis of the bladder-walls, diverticula, cystocele, etc., were present to prevent its passage.

The majority of the stones found in the female bladder are deposited around foreign bodies. The most common of these are hairpins, pieces of pencil, chewing-gum, etc., introduced into the bladder by the patient herself; and sutures or ligatures, inserted by the surgeon, which have worked their way into the bladder through its walls. These bodies are usually septic when introduced, and phosphatic salts are soon deposited around them.

The presence of vesical calculi is first manifested by the ordinary

symptoms of cystitis. The pain, however, is, as a rule, more **marked** than in ordinary cystitis; and is more intense after urinating, when the bladder-walls contract upon the stone.

The **diagnosis** of vesical calculus depends upon detection of the stone by the cystoscope or sound, or by palpation on bimanual examination.

The **treatment** consists in removal of the stone. This can usually be accomplished through the dilated urethra, either with or without preliminary crushing, according to the size of the stone. If, for any reason, the urethra cannot be utilized, the stone may be removed through a vaginovesical incision or, preferably, by suprapubic cystotomy.

CHAPTER XXIII.

SURGERY OF THE UTERUS.

Fibroid Tumors.—Fibroid tumors of the uterus consist of elements similar to those composing the normal structure of the uterine walls in which they originate. The connective tissue and unstriped muscular tissue are found in varying proportions, the former being in excess. The terms used to designate these growths are fibroma, myoma, fibromyoma, and myofibroma, the latter two indicating the preponderance of fibroid or muscular tissues. While of mixed character histologically, the natural history of the several varieties is practically the same. Hence, the common term fibroid tumors will be found most convenient and sufficiently accurate to designate the neoplasms under consideration.

While these growths are benign in the sense that they do not infiltrate contiguous structures nor infect the system, they are not so harmless as formerly regarded. They undermine the health and shorten life by hemorrhage; they interfere mechanically with the functions of important organs; they often become infected and give rise to sepsis; and they frequently undergo transformation into sarcoma.

Pathology.—Fibroid tumors of the uterus vary in size from a growth the size of a pea to a mass weighing more than a hundred pounds. They are seldom single, though one or more may outgrow all others and give the appearance of a single large rounded or nodular tumor. In such cases, if the uterine wall is carefully examined, other small tumors will be discovered. They are usually irregular in form, growing in the various directions of lessened resistance.

Fibroid tumors usually start from the body of the uterus, and most frequently from the posterior wall. Rarely, they are found growing from the infravaginal portion of the cervix. Occasionally, the tumor originates in the supravaginal cervix and grows upward within the folds of the broad ligaments. It is customary to classify these tumors in accordance with their relation to the normal uterine structures. When situated in the uterine wall, they are termed (1) *interstitial;* when projecting outward beneath the peritoneum, they are known as (2) *subserous;* and when protruding into the cavity of the uterus, they are called (3) *submucous.* When they grow from the supravaginal cervix and extend outward between the folds of the broad ligaments, they are termed *intraligamentous.* It is not uncommon to find one specimen that will illustrate two or more varieties under this classification.

When the growth originates immediately beneath or near the peritoneum, it will grow toward the peritoneal cavity, since it will meet with less resistance in that direction. The tumor may be so connected with the uterine parenchyma as to become pedunculated. The pedicle

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FIG. 394.—Fibroid tumors of the uterus, interstitial and subserous: *a*, point of amputation at the internal os.

FIG. 395.—Fibroid tumors of the uterus, interstitial and subserous.

will vary in length and thickness. As a result of traction, violence, or atrophy, the pedicle may become twisted, producing gangrene ; or entire separation may occur, followed by attachment of the tumor to adjacent structures. When a subserous fibroid tumor grows from the anterior aspect of the cervix, it often carries the vesico-uterine fold of peritoneum upward, and with it the bladder, spreading this viscus upon the surface of the tumor. The ureter also may be uplifted, so as to be found passing over the summit or side of the growth. When the tumor grows from the posterior aspect of the cervix, the peritoneum may be displaced upward, so that the tumor becomes retroperitoneal.

When the tumor originates near the uterine mucosa and grows beneath that membrane, it may become extruded into the uterine cavity and there form a pedunculated tumor. This is known as a *fibroid polyp*. The intra-uterine polyp will gradually assume the form of the uterine cavity. The presence of the tumor in the cavity of the uterus excites contraction of that organ, and the tumor will be expelled from the uterus after a time, to be found in the vagina. This is the most common variety of uterine polypi. The pedicle is lengthened by this process, and the vascular supply lessened. Sloughing is very common under these conditions. The fibroid polyp is more frequently single than any other variety of fibroid tumors of the uterus.

These neoplasms vary in consistence from the soft edematous myoma to the hard nodules composed almost wholly of fibroid tissue. When section is made, the growth presents a white or rosy appearance, illustrating the varying proportions of fibroid and muscular tissues. The tumor is loosely attached to the adjacent uterine wall, being invested by a capsule of loose connective tissue, from which it is readily enucleated. Its loose attachment to the surrounding uterine wall accounts for the ease with which the growth may be extruded beneath the peritoneum or the mucous membrane of the uterine cavity. Small blood-vessels enter the tumor from its capsule.

The development of these growths is most diverse. As a rule, they are of slow growth ; but in exceptional instances they increase with the same rapidity that characterizes ovarian tumors. Again, the tumor may cease to grow after the menopause ; while in exceptional instances it may take on increased activity after that change. In some instances the tumor seems to reach a maximum growth and remain inactive, while in other cases it steadily increases until it occupies the entire abdominal cavity and destroys the woman's life by pressure.

Marked changes in the uterus and the adnexa take place in connection with fibroid tumors. The entire uterus increases in size. The muscular wall is thickened, the cavity is enlarged, and the endometrium undergoes atrophic and inflammatory changes. The endometritis frequently extends to the Fallopian tubes, begetting pyosalpinx and, less frequently, hydrosalpinx. The tubes and ovaries may be displaced in various directions by the irregular growth of the tumor. The blood-supply of the uterus is increased by hypertrophy of the ovarian and uterine arteries and their branches. The veins in the broad ligaments, too, are conspicuously enlarged ; and large venous sinuses will be found in the capsule of the tumor.

During menstruation and pregnancy these growths increase in size,

the enlargement being due to changes in the circulation and consequent edema of the tumor. After parturition marked diminution in size takes place, and it is claimed that the growth sometimes disappears altogether. In a considerable proportion of cases these tumors undergo progressive induration, and decrease in size after the menopause.

Fibroid tumors are subject to several forms of degeneration. Of these varieties of degeneration, the *fatty*, the *calcareous*, and the *myxomatous* are so rare as to deserve mention only.

In the *edematous fibroid* tumor, the entire structure, both fibroid and muscular tissue, is infiltrated with a serous fluid. This condition is not uncommon, and is usually observed in young women. It is closely allied to *cystic degeneration*, in which the constituent elements are displaced by the serous fluid. Cystic cavities may occur as the result of several degenerative changes, the fibroid then being known as a *fibrocystic* tumor. These fluid accumulations are without the epithelial lining that distinguishes true cysts.

Inflammation may obtain in fibroid tumors, often resulting from traumatism of the uterine mucosa during examination with the sound or treatment with the curet and other agencies.

Gangrene is not uncommon in fibroid polypi, in consequence of constriction of the pedicle during the process of extrusion from the uterus.

In the interstitial fibroid, *gangrene* and *suppuration* may take place in the central parts of the growth. In one of the writer's cases gangrene and suppuration were disclosed by section of the tumor, the result, doubtless, of circulatory changes.

Fibroid tumors of the uterus are prone to *sarcomatous degeneration*. Indeed, some pathologists maintain that uterine sarcoma invariably begins in degeneration of a fibroid tumor. The trend of clinical observation is to establish the belief that fibroid tumors predispose to sarcoma. While *carcinoma* frequently occurs in the fibroid uterus, it is usually in its most frequent site (the portio vaginalis); and it can scarcely be claimed that the fibroid predisposes to cancer or is prone to carcinomatous degeneration.

Etiology.—Despite careful study and numerous theories, the cause of fibroid tumors of the uterus is unknown. These tumors have been found prior to puberty; but, being of slow growth, they produce no symptoms until the age of sexual activity. They usually come under the physician's observation between the thirtieth and fortieth years. Uterine fibroma is essentially a pathological condition incident to the menstrual period of woman's life. Menorrhagia and deferred menopause are common accompaniments. In a large proportion of cases the tumor ceases to grow after the menopause, and participates in the retrograde changes which at that time obtain with the genital organs. In this way it may undergo physiological atrophy, and all symptoms may abate. This happy relief is not, however, the invariable sequence of the menopause. In many instances the tumor grows uninterruptedly after the menopause. In a case under the writer's care, the tumor took on increased activity after the menopause, which occurred at the age of forty-eight. At the age of fifty-two the tumor had filled the entire abdomen, and the woman was in an alarming condition when relieved by complete removal of the growth.

Fibroid tumors are common to both multiparous and nulliparous women, though found more frequently in the latter class. Indeed, these tumors are among the most common of all the diseases peculiar to women. Unmarried women, and married women who have never conceived, are especially prone to this disease. It is apparent that the arrest of menstruation by pregnancy and lactation, and the retrograde changes accompanying involution of the uterus, are means of protection against the development of uterine fibroids.

These neoplasms are common in both the white and the black races, but more common in the latter.

Symptoms.—*Hemorrhage* is the most conspicuous symptom of fibroid tumors of the uterus. While this symptom is observed in the majority of cases, it is not invariably present: often large interstitial and subserous tumors exist without hemorrhage, and small subserous tumors may exist without any symptoms whatever. The hemorrhage may appear either as a profuse and prolonged menstrual flow (menor-rhagia), or as a continuous and persistent uterine hemorrhage (metror-rhagia). As a rule, the hemorrhage is not so excessive as to exhaust the patient, and may be controlled by rest and appropriate remedies. In many cases the hemorrhage may be so great as to produce marked anemia; while in exceptional cases the patients become exsanguined from copious and persistent bleeding. In cases of submucous tumors (fibroid polypi), death may result directly from hemorrhage.

The increased area of the endometrium and the diseased condition of that membrane are the cause of the hemorrhage. The site of the tumor has more to do with the severity of the hemorrhage than its size. The submucous tumors produce the most severe hemorrhage, the inter-stitial less, and the subserous least. The histological structure of the tumor influences the tendency to hemorrhage. This symptom is more active in soft and edematous fibroid tumors.

Pain is a constant symptom of fibroid tumors. It results from a variety of causes, and hence varies in character. The pain of pressure is seldom in proportion to the size of the tumor, but is determined more by the site of the neoplasm. Thus, when the growth springs from the lower uterine segment and occupies the pelvic excavation, the pain from pressure upon the bladder, bowel, and nerve-trunks will be more severe than when the tumor rises freely above the pelvic brim. Pressure upon the bladder, producing vesical irritation, and pressure upon the bowel, inducing obstipation and hemorrhoids, are the most severe and com-mon types of the pressure-pains accompanying fibroids of the uterus. The metritis and endometritis associated with these growths, together with the accompanying salpingitis and peritonitis, account for much of the pain and discomfort. These symptoms are naturally intensified at the menstrual periods. The pain of uterine contraction is associated with the expulsion of submucous fibroids from the uterus. The pain and discomfort of intraligamentous fibroids are most marked. The bladder and urethra may be so distorted by the growth that urine is voided with much pain and difficulty. In one of the writer's cases the patient could only void her urine when standing in the erect position. Pressure upon the ureters may result in obstruction, hydronephrosis, and uremia.

The **diagnosis** is made by careful physical examination, by observing the symptoms above described, and by comparing them with those appertaining to other growths that resemble these tumors. By bimanual examination the presence of a tumor, its irregular outline, and its attachment to the uterus may be determined. If the tumor is large, one can detect its firm consistency and nodular character by palpation through the abdominal parietes. The finger in the rectum will detect small growths upon the posterior surface of the uterus, and aid in determining the relation of larger growths to the uterus.

Interstitial fibroid tumors which produce symmetrical hypertrophy of the uterus are liable to be mistaken for pregnancy. While generally the diagnosis between uterine fibroma and pregnancy is not difficult, both this error and the reverse have been made, and the mistake not discovered until the abdomen was opened. In making the differential diagnosis in such cases, the slow growth of fibroid tumors, the existence of menorrhagia and metrorrhagia, the hard cervix, and the absence of the prominent symptoms of pregnancy will afford a basis of differentiation usually sufficient. The coexistence of fibroid tumors and pregnancy is not very infrequent, and this fact should be remembered.

It is very difficult to make the differential diagnosis between ovarian cyst and the soft edematous fibroid tumor. Differential diagnosis is also most difficult between ovarian cysts and fibrocystic tumors. Fluctuation is present in all alike; and the differential diagnosis must be made by determining the connection of fibroid tumors with the uterus, as shown by mobility of the cervix when the tumor is manipulated through the abdominal wall. An error in diagnosis here is not so serious, since the treatment for all consists in removal of the tumor by abdominal section. An experienced surgeon will readily recognize the nature of the tumor as soon as the abdomen is opened. Fibroid tumors springing from the cervix, with adhesions, may readily be mistaken for intrapelvic inflammatory exudate. A small fibroid tumor in the posterior uterine wall may be mistaken for retroflexion of the uterus. The careful use of the uterine sound will correct this error. In the diagnosis of submucous fibroids, direct examination of the interior of the uterus will usually disclose the character of the growth.

Prognosis.—While, as already stated, fibroid tumors of the uterus are benign, in contradistinction to cancer and sarcoma, they are not devoid of danger to life; and this fact must be borne in mind in making a prognosis in a given case of uterine fibroma. The tumor may be extruded from the uterus in the form of a polyp and result in spontaneous cure. In cases of the subserous and interstitial varieties, atrophy and cessation of all pain and hemorrhage may take place after the menopause. In other cases the submucous tumor may endanger life by hemorrhage. In young women with growing tumors, years of invalidism are to be expected, with the ever-present danger of intercurrent complications and possible degenerative changes. While life is not directly and immediately threatened, a condition of invalidism is established which restricts the patient's activity, prevents her from earning a living, and subjects her to many perils. With the liability of sarcomatous degeneration, together with renal and digestive disturbance, with protracted anemia and consequent impaired vitality, with the danger of

thromboses originating in the dilated blood-spaces of the tumor, and with sepsis, the prognosis of fibroid tumors involves possibilities which must be regarded as most serious.

Treatment.—The treatment of fibroid tumors of the uterus requires the exercise of good judgment, after deliberate consideration of the requirements of individual cases. As the operative technic has been improved, palliative and expectant methods of treatment have given place to surgical interference. While rest and tonic measures may alleviate symptoms and prolong life, operation alone can secure permanent relief and cure. Hence, in the majority of cases immediate operation is indicated. The exact character of operation, as well as the adaptation of the operative procedure to individual cases, demands the highest surgical skill and experienced judgment. Formerly, when the results of operation were marked with severe mortality, women afflicted with these tumors were consigned to invalidism, with much suffering, through the active period of life, looking to the menopause for relief. Many died from the accidents and complications to which these tumors are prone ; while others found the menopause deferred or the tumor actively growing after that period. With the perfected methods of modern surgery, the danger of operation has been reduced, until it is less than the dangers inseparably connected with these tumors. Operative treatment is now so safe that it is not to be restricted to the class of large tumors, or to smaller growths complicated in various ways, wherein life is directly threatened ; but in cases of fibroid tumors in which the health is impaired by hemorrhage and pressure of less urgency, but sufficient to beget invalidism, permanent relief should be attained through operation. In young women with actively growing tumors, protracted delay to await the increase of symptoms, while invalidism is already established, is inadmissible. When the tumor is of small size and unaccompanied by hemorrhage, pain, or other serious symptoms, operation should not be advised. Under these conditions the patient should be kept under observation, and no treatment should be instituted as long as the tumor remains of small size and health and comfort are maintained. If the tumor arises from the lower segment of the uterus, and especially if intraligamentous, operation should be advised even if the tumor is of moderate size. Such tumors almost invariably pack the pelvic basin so as to produce severe pressure-symptoms. If pregnancy should occur, the tumor will produce abortion or later obstruct labor. Hence, the site of the tumor, rather than its size, may determine the necessity for operation.

From the preceding, it is apparent that the surgeon will give consideration to the requirements of individual cases in deciding the important question of operative treatment. In those cases wherein it is decided not to resort to operation, definite attention must be given to symptoms that arise.

The mere presence of a small subserous or interstitial fibroid does not indicate treatment of any kind, nor forbid prolonged exercise and activity. It is only when such symptoms as hemorrhage and anemia, pressure and pain, are present that symptomatic and palliative treatment are indicated. For these symptoms, rest is most important. Especially should rest be observed at the menstrual periods. Mild purgation with

salines relieves congestion by depleting the pelvic circulation, and should be conjoined with rest in the treatment of these cases.

For excessive hemorrhage, the most efficient treatment is to curet thoroughly the mucous membrane of the uterus. The uterine cavity should, of course, be packed with sterilized gauze upon completion of this operation. The benefit of this treatment usually lasts several months, when it may be repeated. The operation should be done in a thorough and surgical manner, with rigid observance of all aseptic precautions.

Various drugs, such as ergot, gallic acid, hydrastis, and some preparations of iron, are in popular favor to control the bleeding of fibroid tumors; but in the opinion of the writer they are both inefficient and harmful. Such remedies in moderate dosage exert no perceptible influence upon the hemorrhage of uterine fibroids; while they have the disadvantage of constipation with congestion of the pelvic circulation, impairment of appetite, and interference with the eliminative functions generally. Hemorrhage will be more influenced by rest, saline purgatives, unstimulating diet, and the moderate use of the hot vaginal douche than by any drugs known to modern therapeutics.

The results claimed a few years since for electricity in the treatment of uterine fibroids have not been sustained by increased experience, and this agent has deservedly passed out of use. It is doubtful if it is of appreciable value in controlling any symptoms, while it does not arrest the growth of the tumor. The treatment by electropuncture is followed by localized peritonitis and adhesions, and is harmful. Treatment by hypodermic injections of ergot, formerly in vogue, is subject to similar objections.

When a submucous fibroid projects into the uterine cavity and becomes pedunculated, it should be removed. This operation should, of course, be done by the vaginal route. In a majority of the cases that apply for relief, the tumor will be found projecting from the external os, often filling the vagina. If the tumor is within the cavity of the uterus, it will be necessary to dilate the cervix, so as to reach the pedicle and remove the growth. Submucous tumors that are sessile may likewise be removed from the interior of the uterus when they are situated low down. The feasibility of this procedure depends on the condition of the cervix. If the cervical canal is open, or if it can be dilated sufficiently, the operation can be readily done. The capsule should be opened at the most dependent point of the tumor and stripped away. The tumor is then to be seized with the volsellum upon its uncovered surface, and enucleated with the finger. Care must be observed, if instruments are used in enucleating, not to penetrate the wall of the uterus. If the capsule be respected in this procedure, the hemorrhage will be slight; and contraction of the uterine fibers, aided by gauze-packing, will readily control it.

When a submucous fibroid tumor has become polypoid and has been extruded into the vagina, filling that canal to its full capacity, it may be necessary to remove it by morcellation. These tumors are not vascular, and large vessels will seldom be found in the pedicle. Division of the pedicle with the écraseur, or transfixing and tying with a double ligature, will be found unnecessary; the retraction of the

pedicle and contraction of the uterine fibers about it will arrest the hemorrhage. Should any hemorrhage persist, it may be controlled by packing the uterus with sterilized gauze. By traction these tumors may produce partial inversion of the uterus at the site of the pedicle; hence, the pedicle should be divided with the scissors closer to the tumor than to the uterine wall.

If the tumor is sloughing, as is very common, the most thorough antiseptic precautions, including irrigation and drainage, should be observed. In all cases the vagina should be packed with iodoform gauze after completing the operation, and the after-treatment conducted as is customary after operations upon the uterus by the vaginal route.

The operations to be applied to the treatment of uterine fibroid tumors which are subserous, or interstitial, or mixed, are salpingo-oöphorectomy, ligation of the uterine arteries, myomectomy, and hysterectomy.

Salpingo-oöphorectomy has been practised as a conservative operation in fibroid tumors, and in properly selected cases yields excellent results. Recognizing that fibroid tumors are incident to the period of menstrual life; that they cease to grow after the menopause, and undergo atrophic changes thereafter in a considerable proportion of cases; and that menorrhagia is a serious complication, removal of the uterine appendages in order to establish prematurely the menopause will commend itself at once as a rational procedure. This operation has been applied with success for a number of years, though it has been discredited by failure to restrict its application to a very limited class of cases. This procedure is applicable only to small and medium-sized interstitial fibroids, in which the most prominent symptom is hemorrhage, and in which pressure-symptoms are not marked. The soft edematous fibroid is not usually affected by the operation; while fibrocystic tumors are not influenced in growth or otherwise. The effect of the operation varies. In some cases arrest of hemorrhage and beginning atrophy are immediate results of the operation; while in others the benefits of the operation are slow in appearance. In performing the operation, care should be observed to remove the ovaries entirely, and also to amputate the Fallopian tubes close to the uterus. Neglect of these precautions has caused failure of the operation in many instances. In some cases the appendages are so distorted by the irregular growth of the tumor, displaced behind or beneath, or incorporated with the capsule, that they cannot be removed. Hence, in undertaking this operation, the surgeon should be prepared to do hysterectomy if it should become necessary. The improved technic and increased safety of hysterectomy have diminished the field of this operation, until it is limited now to a small class of cases of the character described, in which some special complication contra-indicates hysterectomy.

Ligation of the uterine arteries has been recently practised to some extent in the treatment of uterine fibroid tumors, the object being to arrest growth and secure atrophy by lessening the blood-supply. This operation has not been generally adopted, and reported results are too meager to establish its efficacy. The treatment of large tumors by this method is impracticable; and in tumors springing from the lower seg-

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ment of the uterus, the artery may be displaced from its normal position so as to prevent its being reached.

Myomectomy.—Whenever it is possible to remove a morbid growth from any organ without destroying that organ, and at the same time restore the patient to health, it should be done. This is ideal surgery. Unfortunately, however, it is only in exceptional cases that this rule can be applied to the surgical treatment of fibroid tumors of the uterus.

As has been already stated, fibroid tumors are usually multiple; and this is especially true of the subserous and interstitial varieties. Myomectomy consists in removing the tumor or tumors and preserving the uterus. It is applicable only to cases of subserous pedunculated tumors and to single interstitial fibroids. When the tumor is pedunculated, the pedicle is transfixed and tied with a double ligature, and the tumor cut away. It will be necessary to introduce some deep sutures of catgut to guard against hemorrhage. If the tumor is interstitial, it will be necessary to split the capsule and enucleate the growth. Care must be observed in these cases not to open into the uterine cavity, particularly if that cavity has not been sterilized by curettage and irrigation as a preparatory step of the operation. The wound in the uterine wall must be closed by deep and superficial rows of catgut sutures. The danger of the operation lies in possible post-operative hemorrhage. When small nodules are left in the uterus after removal of larger tumors they are prone to grow, and necessitate a second operation. Hysterectomy is a safer operation than myomectomy, is preferable both on account of its immediate and remote results, and should be preferred except in the class of cases above indicated.

Hysterectomy, or, more properly, *hysteromyomectomy*, involves removal of the entire growth, including the uterus. The uterine appendages, as a rule, are also included in the excised mass. This operation has been so perfected in the evolution of pelvic surgery that its dangers are no greater than those connected with ovariotomy and salpingo-oöphorectomy. For this reason, and the additional one that the cure is complete and perfect, it has become eminently the operation of election for fibroid tumors of the uterus.

The operation of hysterectomy for fibroid tumors may be either partial or complete. In partial hysterectomy the uterus is amputated through the cervix, just above the vaginal attachment. In complete hysterectomy the entire uterus, including the cervix, is removed. Partial hysterectomy may be done after two distinct methods. In one the pedicle is treated extraperitoneally by fixation in the lower angle of the abdominal incision; in the other the pedicle is " dropped " and the cervix and superimposed peritoneum sutured, so that the pedicle is retroperitoneal. The three methods are practised with varying favor and preference by different surgeons, and with constantly improving results. It is the writer's conviction that no one of the three methods should be applied to all cases, but that the operator should be guided in the selection of the method by the requirements of the case in hand. When the patient is feeble, or exhausted by hemorrhage, and it is of paramount importance to complete the operation quickly, the extraperitoneal method is preferable.

The patient having been prepared for abdominal section as elsewhere

described in this volume, the abdomen should be opened in the median line by an incision long enough to permit removal of the tumor. Care should always be observed to avoid injury to the bladder. Adhesions having been separated and all bleeding points secured, the tumor is dislodged and brought out through the abdominal incision. This maneuver, as well as easy manipulation of the tumor in the further steps of the operation, will be facilitated by inserting a screw (Fig. 396) into the tumor, as recommended by Lawson Tait.

Large gauze pads are packed inside the cavity to protect the intestines and absorb fluids. After delivery of the tumor, the further steps of the operation will be materially facilitated by placing the patient in the Trendelenburg position. The next step in the operation relates to the ligature and division of the broad ligaments. A strong silk ligature is placed in the broad ligament, outside the ovary and tube. The broad ligament is again transfixed and another ligature applied below, securing the round ligament. A clamp is then applied at the cornua of the uterus, so that hemorrhage from the tumor will be prevented when the ligament is divided. The same procedure is then done on the opposite side. The ovarian vessels are thus secured. The broad ligament on each side is severed

Fig. 396.—Myoma-screw (half size).

between the ligatures and clamps with scissors, being careful in each instance to cut closer to the clamp than the ligatures. In this step of the operation the operator should have in mind the frequency of slipped ligature and hemorrhage, and avoid fixing the ligature while the ligaments are on the stretch. Indeed, this danger is so real and great that it is better to place the clamp, transfix the broad ligament with the ligature, and secure the ligature-knot while the ligament is being divided by the assistant with the scissors close to the clamp. With each cut of the scissors the ligature can be drawn tighter. Attention is next turned to the relation of the bladder to the anterior surface of the tumor. When necessary, the peritoneum covering the anterior surface of the tumor may be divided transversely, and with the handle of the knife or the finger stripped down, so as to allow the bladder to fall forward and away from the tumor. If the tumor has developed in the folds of the broad ligaments, is held down in the pelvis and fills it, these directions will have to be varied accordingly. The intraligamentary space will be opened and the tumor freed, vascular attachments being secured with forceps until the tumor can be delivered. It will be best in all such cases to open the broad ligament on one side and get beneath the tumor, ligating the vessels on that side. Enucleation will be much easier from below than from above. The vessels of the opposite side can be secured as they are reached in the process of enucleation.

When the tumor has been thus released by deligation and division of the upper portion of the broad ligaments, it will remain attached

to the lower portion of the broad ligaments and the vagina. The next step in the operation is the *treatment of the pedicle*. The pedicle is the cervix uteri. In most instances the tumor will be found to occupy the body of the uterus, so as to leave the cervix of normal size and conformation. If the pedicle is not of such size and conformation, it should be trimmed down and thereby reduced. The pedicle should consist of the cervix alone, and not a part of the tumor or body of the uterus.

If the *extraperitoneal method* be adopted, Koeberle's wire clamp, or serre-nœud (Fig. 397), should be applied. In adjusting the wire, care must be observed that the bladder be free. As soon as the wire is tightened, one or two long pins should be passed through the pedicle immediately above the constricting wire, and the uterus and tumor amputated about ½ inch above the constriction. While the stump is held in the lower angle of the incision with a volsellum by an assistant, the abdomen is cleansed of clots, the ligatured stumps of the broad ligaments carefully examined, the omentum drawn down to its place, and the abdomen closed. In closing the lower angle of the incision, the parietal peritoneum should be united by a suture of catgut to the peritoneum of the stump immediately below the constriction, in order quickly to shut off the peritoneum from the stump. The parietal incision is closed in the usual way with interrupted sutures of silkworm-gut, and made to hug the stump below the transfixion-pins. The pins maintain the stump at a proper level. At the conclusion of the operation, the wire should be tightened with a few turns of the key, so as to produce complete anemia of the stump. The pedicle should be dried, dusted liberally with iodoform, and dressed with gauze. The wire clamp will drop off at the end of ten days or two weeks. When all necrotic tissue has come away a deep granulating space will be left, which will rapidly heal and contract.

FIG. 397. — Koeberle's serre-nœud (half size).

This method is commended by the rapidity with which it can be done and by the perfect control and safety as to hemorrhage that it assures. Its disadvantages are the prolonged convalescence necessitated by granulation of the pedicle excavation, and the liability of hernia at the side of the pedicle.

The *intrapelvic method* of treating the pedicle involves the same steps in releasing the tumor from the upper portion of the broad ligaments that have been described. When the uterus has been freed from its attachments on each side down to a point somewhat above the level of the internal os, the peritoneum is divided transversely across the anterior surface of the tumor where the peritoneum is reflected from the uterus to the bladder. This incision should connect the two incisions which have already been made to divide the broad ligaments. The bladder is now pushed down off the uterus and cervix to the vaginal junction. The vaginal portion of the cervix should be located by thumb

and finger, and the uterine arteries found by palpation. While the tumor is drawn upward a ligature should be passed close beside the cervix on each side, so as to secure the uterine arteries. The ureter lies about ½ inch from the side of the normal cervix and at the level of the external os. When the uterus is drawn upward, this distance is appreciably lengthened; but it is important to remember that the ligature should be passed close to the cervix. In passing the pedicle-needle, care must be observed to avoid the cervical tissue as well as the ureter. The ligature may be placed inside the separated folds of the broad ligament, or made to encircle the double fold of ligament, and artery at one sweep. The bases of the broad ligaments should then be divided with scissors between the cervix and ligatures, leaving ample tissue above the ligature to prevent slipping. While the tumor is still drawn upward a wedge-shaped incision is made deep in the cervix, completing the excision of uterus and tumor. The cervical tissue is closed over the cervical canal by interrupted sutures of catgut. The peritoneum in front (the anterior layer of the broad ligament and the vesical reflection) and the posterior peritoneal layer are united by a continuous catgut suture, covering the entire wound-area, inclusive of the cervical stump. The stump is consequently extraperitoneal, but intrapelvic. This method is commended by its completeness as a surgical procedure, and by a convalescence which, when uninterrupted, is easy and rapid. It requires more time for its completion than the extraperitoneal method, and the buried ligatures and anemic stump are prone to suppuration in the cellular tissue beneath the peritoneum.

The operation of *total hysterectomy* is the operation just described, with the addition that the cervix is removed entire at the vaginal junction. As a rule, the ligatures are left long, so that the ends may be drawn down into the vagina. After the vessels have been secured, the broad ligaments severed, and the bladder separated from the uterus and upper part of the vagina, an incision is made with knife or scissors into the anterior vaginal fornix, and continued around until the cervix is released. Bleeding vessels in the severed wall of the vagina are secured by catgut ligatures. The ureters must be carefully avoided. When hemostasis is complete, forceps are passed through the vagina from below, and the ligatures gathered together and brought down into the vagina. Strips of iodoform gauze are placed about the stumps in the pelvis, and the ends carried into the vagina for drainage. The abdomen is closed in the usual way. The gauze should be removed at the end of a week, when gentle traction may begin to be applied to the ligatures, and repeated every day or two until they come away.

Many surgeons prefer to close the vagina after excision of the cervix, at the same time cutting the ligatures short. The vagina is sutured by passing the sutures through the outer portions of the vaginal wall, without entering the vaginal canal. This operation has the advantage of leaving no stump whatever to be disposed of by clamp-necrosis or to become encapsulated beneath the peritoneum. It is a complete extirpation. It requires longer time for its performance than amputation by either method, and this is the chief obstacle to its general adoption. The operation of supravaginal amputation with dropped extraperitoneal pedicle is, on the whole, to be preferred.

to the lower portion of the broad ligaments and the vagina. The next step in the operation is the *treatment of the pedicle*. The pedicle is the cervix uteri. In most instances the tumor will be found to occupy the body of the uterus, so as to leave the cervix of normal size and conformation. If the pedicle is not of such size and conformation, it should be trimmed down and thereby reduced. The pedicle should consist of the cervix alone, and not a part of the tumor or body of the uterus.

If the *extraperitoneal method* be adopted, Koeberle's wire clamp, or serre-nœud (Fig. 397), should be applied. In adjusting the wire, care must be observed that the bladder be free. As soon as the wire is tightened, one or two long pins should be passed through the pedicle immediately above the constricting wire, and the uterus and tumor amputated about $\frac{1}{2}$ inch above the constriction. While the stump is held in the lower angle of the incision with a volsellum by an assistant, the abdomen is cleansed of clots, the ligatured stumps of the broad ligaments carefully examined, the omentum drawn down to its place, and the abdomen closed. In closing the lower angle of the incision, the parietal peritoneum should be united by a suture of catgut to the peritoneum of the stump immediately below the constriction, in order quickly to shut off the peritoneum from the stump. The parietal incision is closed in the usual way with interrupted sutures of silkworm-gut, and made to hug the stump below the transfixion-pins. The pins maintain the stump at a proper level. At the conclusion of the operation, the wire should be tightened with a few turns of the key, so as to produce complete anemia of the stump. The pedicle should be dried, dusted liberally with iodoform, and dressed with gauze. The wire clamp will drop off at the end of ten days or two weeks. When all necrotic tissue has come away a deep granulating space will be left, which will rapidly heal and contract.

FIG. 397. — Koeberle's serre-nœud (half size).

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In the preparation of patients for hysterectomy, the vagina should be thoroughly scrubbed and disinfected.

The dangers of these operations are shock from prolonged operation; hemorrhage, primary and secondary; and sepsis.

When fibroid tumors complicate pregnancy, the decision of the important question of operative interference is one of great responsibility. In treating the pathology of these tumors, we have learned that they grow rapidly during pregnancy and undergo atrophic changes after parturition. Subserous tumors near the fundus are pushed up

FIG. 398.—Fibroid tumor of the uterus complicating pregnancy; the tumor occupied the pelvic basin beneath the uterus (photographed as removed by operation).

FIG. 399.—Fibroid tumor of the uterus complicating pregnancy; uterus incised and emptied.

out of the pelvis as the uterus increases, and pedunculated tumors may be pushed out of the way during the progress of labor. When the tumor springs from the lower segment of the uterus or the supravaginal cervix, and is interstitial, hysterectomy is positively indicated. Such a case is illustrated in Fig. 398.

If not discovered until near the end of pregnancy, it will be best to await the advent of labor and resort to the Porro operation.

Carcinoma of the Uterus.—Cancer of the uterus is a very common disease, and may originate both in the cervix and body of the

organ. The cervix is its most frequent seat; indeed, cancer of the body of the uterus as a primary affection is comparatively rare. While the disease may appear at almost any period of life, it is exceptional for it to occur under the age of thirty; it is most common between the ages of forty and fifty years. It is rarely found in women who have never conceived. It usually appears in women who have borne several children; and the lacerations of parturition, so frequently the seat of erosion, seem to afford a focus of infection and invite the development of this disease. The structures in which cervical cancer originates are (1) the epithelium covering the vaginal portion of the cervix, (2) the epithelium lining the cervical canal, and (3) the epithelium of the cervical glands. Cancer of the body of the uterus originates in the epithelial structures of the endometrium.

Cancer of the cervix may, in a general way, be divided, in the order of frequency, into the following varieties: 1. *Adenoid* cancer, which sooner or later assumes the medullary type. 2. *Medullary* cancer. 3. *Scirrhous* cancer. 4. *Dermoid* cancer. When destructive ulceration takes place in the late stages of the disease, all varieties present similar appearance and symptoms.

The vascular and lymphatic channels of the cervix favor extension of the disease along the base of the broad ligaments through which they course; hence, extensive pelvic infiltration may occur before the body of the uterus becomes involved. The vagina is frequently invaded in the early stages of cervical cancer. When the disease originates in the epithelium of the cervical canal, the endometrium is involved directly, and the body of the uterus is implicated early. The invasion of the broad ligaments causes them to become thickened and rigid, thus fixing the uterus in the pelvis. In the later stages of the disease, the bladder is involved, and often the vesicovaginal septum is penetrated. As disintegration progresses, the rectum and peritoneum may be opened. The peritoneum, by adhesive inflammation, resists invasion from both cancer of the cervix and body of the uterus more effectively than other contiguous structures.

In the early stage of cervical cancer, the erosion is characterized by a tendency to bleed when touched, and a feeling of diminished elasticity and tendency to induration. When ulceration has taken place, vegetations and irregular protuberances appear, friable and hemorrhagic in character. When the disease originates in the cervical canal, the outer aspect of the cervix may appear intact, while an extensive excavation will be found in the cervix. In the late stages of the disease, the cervix is converted into a large ulcerated and gangrenous mass, covered with vegetations and bathed in foul pus and blood.

While cancer of the body of the uterus is uncommon, it is of sufficient frequency to keep the physician always on the lookout for its presence. The disease may first appear on the surface of the epithelium or deep in the utricular glands. In the former instance it will begin as an ulceration or papillary growth; in the latter instance nodules are found throughout the body of the uterus. In the later stages the whole body of the uterus becomes infiltrated, to be rapidly followed by ulceration and disintegration.

Absorption of the discharges into the system begets a general septic

condition, which, with the anemia of incessant and prolonged hemorrhage, is known as the cancerous cachexia.

Symptoms.—In some cases hemorrhage and pain are initial symptoms of the disease; while in others the disease may attain extensive proportions without appreciable symptoms. While the irregular hemorrhages and vaginal discharges described characterize several diseases of mature years in women, such symptoms should always receive careful attention and investigation.

The **diagnosis** is by no means easy in the early stages of the disease. When physical examination is not conclusive, the microscope should be invoked to perfect the diagnosis. No case presenting symptoms at all suspicious should be passed over lightly; and women should be impressed with the importance of seeking advice for even slight irregularities of menstruation occurring near the period of the menopause. In this way many women·could be saved from horrible deaths. The only hope is in an early operation; hence, diagnosis in the early stage of the disease is all-important.

Prognosis.—The duration of life, when the disease pursues its natural course, is from one to three years. The progress of the disease is more rapid in young women. The prognosis here is governed by the same principles that obtain in other parts of the body. When the diseased tissues can be removed completely, and this assured by including an extensive zone of apparently normal tissue, permanent cure in a large proportion of cases may be expected.

Treatment.—The only curative treatment of cancer of the cervix is complete excision of the uterus. Partial operations, such as high amputation of the cervix, and curettage followed by cautery, are no more applicable here than would be similar operations for cancer of the breast or of other organs of the body. This operation is preferably done by the vaginal route, as will be described presently. Abdominal hysterectomy, with excision of the pelvic and retroperitoneal glands, has been advocated by some surgeons; but such aggressive surgery, which, theoretically, is well warranted, is impracticable in cases of cancer of the uterus so far advanced. In addition to the danger of bringing such a septic mass out through the peritoneum, the mortality from such an extensive and prolonged dissection will of itself necessarily be severe. In cases wherein the disease is limited to the uterus, which compose the only class wherein operation can avail, complete hysterectomy, with removal of the appendages by the vaginal route, will accomplish all that any operation can do, and without serious risk to the patient. When the tissues outside the uterus have been invaded, no operation, either by the vaginal or suprapubic route, will yield either temporary or permanent relief. Such operations not only fail to save the patient, but do positive harm in opening up lymphatic channels closed by nature's protecting methods, and start afresh the rapid progress of tissue-infiltration.

Unfortunately, the larger proportion of cases of uterine cancer which apply to the surgeon for treatment belong to this latter class, and have passed the limits for radical operation. In such advanced cases palliative treatment alone is practicable. This consists in curetting away all softened tissues, to be followed immediately by thorough cauterization.

This operation will greatly ameliorate all important symptoms, and will be followed by marked improvement in the general health. Pain should be relieved by the judicious use of opium.

Sarcoma.—Sarcoma of the uterus is rare. It may, however, occur at any time of life; and cases as early as thirteen years of age have been reported. The most usual period is between forty and fifty. This disease appears in the uterus in two varieties: diffuse sarcoma, which invades the mucous membrane; and sarcoma of the uterine parenchyma. The former may become polypoid, and the latter may be nodular. The disease rarely appears in the cervix.

The **symptoms** are very similar to those of fibroid tumors. Hemorrhage becomes more profuse; and the discharge, which at first is serous and without odor, later becomes fetid and loaded with disintegrated tissue. The similarity of the physical signs and symptoms accords with the fact that sarcoma usually originates in degenerative changes in fibroid tumors. Even with the aid of the microscope, diagnosis is often difficult. The **treatment** is the same as that of carcinoma—immediate complete hysterectomy.

Tuberculosis.—Recent researches have shown that tuberculosis of the uterus, while not so common as tuberculosis of the Fallopian tubes, is of more frequent occurrence than formerly supposed. This disease appears first in the endometrium, and usually in the body of the uterus, the cervix being rarely involved, even secondarily. The disease of the uterus is usually secondary to tuberculosis of other parts of the body. Tuberculosis is most common between the twentieth and fortieth years. The **symptoms** are very similar to those of non-tubercular endometritis. The **diagnosis** depends upon microscopical examination of tissue removed with the curet. The **treatment** is vaginal hysterectomy, unless this operation is contra-indicated by extensive tubercular lesions in other parts of the body.

Vaginal Hysterectomy.—The removal of the entire uterus through the vagina has been very generally applied to the treatment of all forms of malignant disease of the uterus since the technic has been perfected under antiseptic methods. Some surgeons prefer the abdominal route of access in extirpating the cancerous uterus, claiming that, with the aid of the Trendelenburg posture, more complete enucleation of carcinomatous tissue can be effected. The vaginal operation, however, is more generally practised in the treatment of cancer; and, with many advantages in this disease over the abdominal method as to immediate results, it is the writer's belief that it is in every way preferable.

Under the stimulating influence of the French school of surgery, vaginal hysterectomy has within very recent years been greatly extended in application, and is now applied to the treatment of suppurative metritis, salpingitis and ovaritis, small fibroid tumors, and extreme cases of complete uterine prolapse. The indications for, and scope of, this procedure in the treatment of inflammatory diseases of the uterus and its appendages have been thoroughly considered in a preceding chapter.

The preparation of a patient for vaginal hysterectomy should begin three or four days prior to the time of operation, whenever practicable. The uterine cervix should be cleansed by thorough curettage, scraping away with a sharp curet all the diseased tissue possible. The cervix

and vagina should be douched with a 1 : 1000 corrosive-sublimate solution, and afterward packed with iodoform gauze. The douche and packing should be repeated daily. If the urgency of the case prevents this preparatory treatment, curettage becomes the first step of the operation of hysterectomy.

Rest in bed, baths, restricted diet, and thorough emptying of the bowels by means of purgatives and enemata comprise the remainder of the preparatory treatment. Immediately before the operation the external genitalia should be shaved, and, together with the vagina, thoroughly scrubbed with soap, hot water, and brush. The patient having been anesthetized, she is placed on the table in the lithotomy-

FIG. 400.—Scheme of the ovarian and uterine and vaginal arteries: 1, uterine branch; 2, branch to round ligament; 3, branches to isthmus; 4, branch to ampulla; 5, fimbriated extremity of Fallopian tube; 6, cervical branch; 7, coronal artery; 8, ovarian artery; 9, ovarian branches; 10, uterine artery; 11, internal iliac artery; 12, vaginal arteries; 13, azygos artery of vagina.

position, with the limbs well flexed and the hips brought to the edge of the table. The posterior vaginal wall is then retracted with a large Sims speculum or Doyen retractor. Constant irrigation should be continued in the first part of the operation and until the peritoneum is opened.

The cervix should be thoroughly curetted, so as to remove all loose diseased tissue, if this has not already been done, and the cervix packed with gauze. The cervix, or the remnant of it, is then seized with strong volsella-forceps, and is drawn down to the vaginal outlet, an assistant retracting the perineum. An incision is made with a sharp knife in a circular sweep around the cervix, dividing the vaginal mucous membrane. This incision should be as far distant from the margin of dis-

eased tissue as possible. Moderate bleeding from the divided mucous membrane may be disregarded; if it is very profuse, pressure-forceps may be applied to all bleeding points. The arrangement of the blood-vessels in the broad ligaments is such that serious hemorrhage from the uterus is prevented by the traction made on that organ. Indeed, the uterus may be bisected in the course of this operation, and if strong traction is maintained there will be no serious hemorrhage.

The knife is now put aside, and the operator proceeds to strip the mucosa away from the cervix. The cellular attachment of the cervix to the bladder in front is pushed away by the finger, being careful to keep close to the uterus and to direct all force toward that organ. Occasionally, it may be necessary to use blunt-pointed scissors to effect this separation, and the precaution just mentioned must be observed to avoid perforating the bladder. When the cervix is enlarged by disease, the ureters lie abnormally close by; and if care is not observed, they may be included in the grasp of forceps or ligature. To prevent this accident, an assistant should lift the bladder with a retractor held from above, as that viscus is released from the uterus.

The cervix is now drawn forward, and Douglas's pouch is snipped open with scissors. The opening is enlarged by introducing the index finger of each hand and tearing the membrane to the base of the broad ligament on each side.

The peritoneum now being open, the irrigation must cease, and a piece of sterilized gauze, with string attached, is passed upward behind the uterus, and allowed to remain until the operation is complete. This gauze pad must be marked by having an artery-forceps clamped to the string attached to it, so as to insure its removal when the operation is completed. This pad will hold the intestines out of the field of operation, and will also protect the peritoneum from fluids and debris in and about the field of operation.

With two fingers of the left hand introduced into Douglas's cul-de-sac the fundus of the uterus will be felt, and these fingers will furnish a guide to opening the vesico-uterine fold of peritoneum, after completing the detachment of the bladder. The uterus will now be attached only by the broad ligaments on each side, containing the uterine and ovarian arteries. These vessels may be secured either by clamp-forceps or by ligatures. With the index finger of the left hand as a guide, the broad ligaments are secured in successive portions by ligatures or strong clamps, and the uterus is cut away as the ligatures or clamps are placed. When the upper portion of the broad ligament is reached, the procedure may be facilitated by anteverting the uterus and bringing the fundus through the incision in the vaginal fornix. When both broad ligaments have been secured and the uterus released on one side, the ovaries and tubes can be brought down and removed with the uterus. This should be done, if possible, in all cases of malignant disease. If ligatures are used, the ends should be left long and protruding into the vagina; and it will be found more convenient to divide the broad ligament entirely on one side, and leave the other to be secured after the uterus is brought out sidewise through the vaginal incision. The writer has in some instances facilitated the operation by using clamps on the broad ligament of one side and ligatures upon the opposite side.

French surgeons rely altogether upon clamp-forceps, and never, so far as the writer's observation extends, use ligatures in vaginal hyster-ectomy. Undoubtedly, the comfort of the patient is better provided for if ligatures are used. It is an excellent plan to replace the clamps with ligatures after completing the operation and before the patient is removed from the table. In using either clamps or ligatures, the ves-sels contained in the broad ligaments should be secured with the utmost care. This should be seen to while the patient is anesthetized and on the table. Two clamps should always be used for each broad ligament. When the broad ligament is clamped by only one long clamp, retrac-tion of the ligament, with hemorrhage, several hours afterward is very liable to occur. Small vessels, such as hemorrhoidal and vesical branches, are usually controlled by clamping them for a time; but if bleeding persists, they should be ligatured before placing the dressings and removing the patient from the table.

The uterus having been removed, the gauze pad is pulled from the pelvis, and the vagina irrigated with hot normal salt solution. The field of operation is then carefully dried and inspected to be sure that all vessels are secured. Finally, strips of iodoform or sterilized gauze are inserted, extending up into the space between the broad ligaments. This space must be loosely packed with long strips of gauze, the ends of the ligatures being carefully placed inside the vagina. The vagina is also packed with gauze; and, if clamp-forceps have been used, gauze should be placed around them to protect the soft parts from pressure. The purpose of the gauze pack is twofold: First, for drainage; and, second, for shutting off the general peritoneum from the operative area, and thereby preventing septic infection. By supporting and holding aside the bladder, rectum, intestines, and omentum, drainage into the vagina is facilitated. The packing should be sufficiently tight to sup-port the viscera in normal position, but loose enough to permit free drainage. The presence of clamp-forceps improves drainage. The catheter should be used to see if the bladder is intact. If the bladder be perforated in the course of the operation, it should be sutured imme-diately. When properly closed at this time, it usually heals perfectly and gives no further trouble.

The **after-treatment,** in general, is the same as in the treatment of cases of abdominal section. The clamps should be loosened, and removed with gentle traction at the end of forty-eight hours. The gauze should be allowed to remain for five days. For its removal, the patient should be placed with the buttocks upon a rubber sheet at the edge of the bed, with the thighs flexed and held by the nurse. The posterior vaginal wall is then retracted with a small Sims speculum and the gauze removed, being careful not to pull on the ligatures, if ligatures have been applied. As soon as the gauze is removed, it must be replaced with strips of fresh gauze. This dressing should be repeated every two or three days for ten days. No vaginal douche of any kind should be used until healing is complete. The patient may get up and about at the end of two weeks.

The surgical treatment of abnormalities of the uterine cervix and lacerations resulting from parturition are discussed in a preceding chap-ter of this volume, to which the reader is referred.

CHAPTER XXIV.

INFLUENCE OF AGE AND RACE IN SURGICAL AFFECTIONS.

THE treatment of racial differences in this chapter will be largely limited to the white and black races of North America, as between these races our opportunities for differentiation are greatest.

To the careful student who reviews the literature of the subject there is no escape from the conclusion that the negro, as we now find him, with changed environments, habits, and associations, is a different being from what he was before the Civil War. He came to America three hundred years ago, with certain immunities and susceptibilities to disease which were so conspicuous as to be noted by all trustworthy observers. A few of the immunities he then enjoyed have been maintained, more lost in part, others wholly exhausted, and to some few diseases (for instance, local tuberculosis of glands, skin, and bones) he shows not only the same liability as the Caucasian, but even exceeds him in susceptibility.

The original susceptibilities of the negro seem to have abided with him and to have undergone less change, he still being as liable to fibroid and other benign neoplasms as he has ever been, as well as to keloid, elephantiasis, and tetanus. Not only is the race manifesting an increasing tendency to disease of all kinds, but statistics of every Southern hospital will prove that the colored race is less resistant and shows a larger mortality, in both medical and surgical affections (operative and non-operative cases), than the Caucasian. The full-blooded negro is less resistant to begin with; and, besides this, the mulatto inherits the weaknesses of both races, the strength of neither, and begins life with the heaviest of handicaps. Therefore, it is not surprising to the observant occasionally to hear such authorities as Hunter McGuire, D. W. Yandell, and other thoughtful practitioners of large experience with this race, say that the African will in time become as extinct in this country as the buffalo and the North American Indian. It is clearly foreshadowed that he cannot maintain the struggle for life with a race his superior in every respect, in a climate to which he is, at best, ill-suited.

Malignant Disease.—All early writers testified to the immunity of the African, in both his native and adopted country, to malignant disease. It cannot be doubted that up to fifty years ago carcinoma was most rare with them as a race, just as it is with all primitive and dark-skinned people everywhere.

Malignant disease (both sarcoma and carcinoma) is certainly increasing in frequency in the black with even greater ratio than in the white race. From a condition of practical immunity, they have become nearly

as liable to malignant disease of some organs as the white, quite as much so to that of the mammary gland, and seemingly more liable to carcinoma of the uterus.

The records of the City Hospital and the Health Department of Louisville for the past thirty years are in line with the statements and statistical data of Billings and Matas, and emphasize especially the frequency of carcinoma of the uterus in negroes. It is impossible to ascertain what per cent. of the cases were in full-bloods, as no distinction is made in the reports between full-bloods and mulattoes. Nor is it possible to determine the relative number of cases of sarcoma and carcinoma; and therefore no attempt is made to do so. It is safe to say,. however, that the negro is relatively somewhat more prone to sarcoma than he is to carcinoma. As has been stated, the mammary gland suffers as often in the black as in the Caucasian; the uterus more often. Now it would appear, *a priori*, that the negro, almost universally affected as he is with phimosis, should show a special susceptibility to carcinoma of the penis; yet I have never seen such a case, nor do the records of our city hospital indicate that one has been treated there in thirty years. Of 207 deaths from carcinoma in negroes reported to the Louisville Health Department in thirty years, none has been entered as carcinoma of the penis.

According to the Eleventh Census, malignant disease occurs in every 100,000 living inhabitants as follows:

Whites 53.93
Negroes 36.65
North American Indians 5.31

The Chinese are slightly less liable than Indians.

To every 1000 deaths from known causes in the United States, in persons over forty-five years of age, there were due to carcinoma and tumor:

Whites 62.86
Negroes 29.81
North American Indians 14.49
Chinese 12.99

In this country, as in England, carcinoma is alarmingly on the increase. Both races show a marked increment of gain; and, so far as carcinomata in general are concerned, the increase has been about the same in the two races, as will be shown by the table giving every death from carcinoma in Louisville for thirty years.[1] These records also show that the number of cases has doubled each decennium, an increase out of all proportion to the gain in population.

Carcinoma of all Parts.—1868 to 1878—total number of deaths, 244: white, 205; colored, 39. 1878 to 1888 total number of deaths, 484: white, 411; colored, 73. 1888 to 1898—total number of deaths, 892: white, 797; colored, 95. Total number of deaths for thirty years, 1620: white, 1413; colored, 207.

The Louisville City Hospital records for the past twenty years agree fully with those of Matas, drawn from the service of the Charity Hospital in New Orleans, and show that malignant disease, instead of being uncommon in the negro, is as often encountered in him in Southern hospitals as it is in the whites. Of 1620 deaths from malignant disease reported to the Louisville Health Office, 1413 were whites and 207

[1] Author's chairman's address before Section on Surgery of the American Medical Association, June 7, 1898.

colored, or about one-eighth of the total number; the normal propor-
tion of colored population to white in Louisville is 1 : 4, which indicates
a mortality in the colored population to be 50 per cent. of what it is in
the white for carcinomata in all situations. This I believe to be nearer
the truth than the smaller hospital series indicates, as it deals with the
entire population of the city; and is, moreover, nearly in accord with
Billings's Eleventh Census statistics (death-rate, 53.93 to 100,000 living
white inhabitants, and 36.65 colored). Further, these represent deaths,
and are not open to the objections that clinical diagnoses may be.

The discrepancy between the statistics of the hospital and the Health Office are apparent
and not real ; for, while the hospital shows the colored race to suffer as often as the white,
it should be remembered that the improvidence and indigence of this race force them into
the city hospital twice as frequently as the more favored whites. The normal hospital pro-
portion of colored to white is just double that shown by the city at large ; hence the two
reports are in perfect harmony, and show that the negro suffers from carcinomata in general
one-half as often as the whites.

Mammary Gland.—Far from being uncommon, as many practi-
tioners believe, malignant disease of the mammary gland is as frequent
in the black as in the white race of North America.

There were 839 cases of carcinoma of the breast reported in the eleventh census: 811
females, 28 males. One occurred under fifteen years of age ; 163 between fifteen and
forty-five ; 670 at and over forty-five. Rate of death to 100,000 inhabitants : females,
8.23 ; males, 0.29. Age : forty-five to sixty-five, 30.08 ; sixty-five and over, 50. Death-
rate practically the same in white (4.27) and colored (4.19).

The records of both the Louisville City Hospital and the Health
Office show a larger per cent. of cases of mammary carcinoma in the
negro than in the white for the past decennium; whereas thirty years
ago it was rarely seen in negro patients of the hospital or reported to
the Health Office as the cause of death.

Contrary to the belief of many, I have learned from extensive cor-
respondence with army surgeons, surgeons to Indian agencies, as well
as others in civil practice in Mexico, New Mexico, and many of our
Western States and Territories, that mammary carcinoma is not infre-
quently met with in Indians and Mexicans. All agree, however, that it
is increasing in frequency in these races ; and that they are now far from
immune to mammary and uterine carcinoma, notwithstanding the con-
trary teaching of all early and modern authors. Nearly all cases of
carcinoma reported in Indians and Mexicans were located in the mammæ
or uterus. Epithelioma of the lips, tongue, and mouth is infrequently
encountered in Indians and Mexicans, in spite of the fact that these
parts are constantly subjected to irritation caused by smoking, a habit
practically universal among them.

Carcinoma of the Uterus.—The Eleventh Census shows carcinoma
of the uterus to be far more common in the colored race. There were
1472 cases reported, and the death-rate was 24.94 in negro, and 14.41,
or but little more than half the number, in white women. The following
table shows the death-rate per 100,000 at all ages during the census
period :

	All ages.	15 to 45 years	45 to 65 years.	65 years and over.
Total	14.93	9.32	54.01	45.91
White	14.41	8.79	52.29	44.36
Native born	10.98	7.51	51.71	43.71
Foreign born	22.92	11.98	50.79	41.77
Colored	24.94	18.82	94.59	88.36

The death-rate is much higher in the colored race for all ages.

Both the Louisville City Hospital and the Health Office statistics show carcinoma of the uterus to be more common in the black race. From 1868 to 1898 there were 272 deaths from carcinoma of the uterus reported to the Health Office of Louisville; of this number, 216 were white and 56 colored; it shows a per cent. against the negro, the normal ratio of population being 1 : 4.

Liable as the mammary gland and uterus of the negro are to malignant disease, certain other regions which one would expect to suffer often do so infrequently. I have never seen carcinoma of the penis, larynx, or tongue in a negro; while rectal carcinomata are common.

Age.—Infancy and childhood are practically exempt from epithelial malignant neoplasms (carcinoma), the youngest case on record being one

FIG. 401.—Sarcoma of the parotid gland; fatal in three months.

of cylindroma of the rectum, in a girl aged eleven (Stern). Carcinoma is rare prior to the age of thirty; it then becomes more common, and is ever thereafter more liable to occur with each succeeding year, and has been reported by Sutton at one hundred and two. Practically all tumors of infancy and early childhood are sarcomata; the first decennium being nearly as exempt from benign neoplasms as it is to carcinomata. Sarcomata of the eye, kidney, testis, and prostate are common in infancy, and may be in many instances congenital.

Duzan analyzed 182 cases of sarcoma in infancy, and found 70 of the eye, 45 of the kidney, 11 of the testicle, 8 of the prostate; while the bones, tongue, abdomen, and brain were affected 5 times each; lung and dura mater, 4 times each; pancreas, 3; liver, tonsil, and rectum, 2 each; and stomach, 1.

During the second decennium, the long bones and maxillæ are the usual sites of sarcoma (Fig. 401). The long bones still suffer in the third decennium; and in the fourth, some of the long bones, as the

humerus, and the mammary gland and testicle exhibit their greatest tendency to sarcomatous change. After forty, sarcoma is rather uncommon until sixty, when it again becomes frequent. Like carcinoma, it is common as a senescent change; but, unlike it, shows its greatest destructiveness in infancy and early childhood.

The following tables are by W. Roger Williams:[1]

TABLE 1.—*Showing the Deaths due to Malignant Disease at Different Age-periods.*

Sex.	All ages.	Under 1 year.	From 1–2.	From 2–3.	From 3–4.	From 4–5.	Total under 5 years.	From 5–10.	From 10–15.
Males . . .	5,754	8	6	6	6	5	31	18	18
Females .	10,489	7	6	6	6	6	31	15	16

From 15–20.	From 20–25.	From 25–35.	From 35–45.	From 45–55.	From 55–65.	From 65–75.	From 75–85.	Over 85.	Total both sexes.
33	50	145	426	1095	1727	1555	591	65	
25	41	321	1313	2464	2922	2330	910	101	16,243

TABLE 2.—*Showing the number of Deaths from Malignant Disease in Early Life per Million Persons Living at each Age-period.*

Age-periods.	Under 5 years.	From 5–10.	From 10–15.	From 15–20.	From 20–25.	All ages.
1861–70	13	7	7	7	17	384
1871–80	12	7	7	15	27	468
1881–90	20	10	11	20	35	589

Benign Neoplasms.—As a class, the mesoblastic benign neoplasms are more common to the negro, he being exceptionally liable to fibroma, lipoma, and keloid.

Molluscum fibrosum, although more frequent in the negro, is more common in the whites of this and even more Northern latitudes than authorities admit. Many speak of it as an affection almost peculiar to the black race of the tropics; yet I have seen 3 most striking instances of this disease in white males, all past forty, within the last four months. I have seen the disease more often in the white than in the black race.

Keloid is also, I take it, more common in the white race than many believe; though it is certainly many times less frequent than in the negro. I have seen a number of typical keloids supervening upon vaccination-scars, on the lobule of the ear after piercing, and on cicatrices variously situated in the white race.

Age.—As has been intimated, the very young are practically exempt from benign neoplasms. The first decennium suffers rarely, and then usually from congenital angiomata and lymphangiomata.

Aneurysm.—According to the Eleventh Census Report, aneurysm is far more common (3 : 1) in the colored than in the white race. The records of the Health Office in Louisville agree fully with Billings's statistics, showing that in a population of 1 : 4 there were nearly as many deaths in negroes as in whites in the last decennial period.

Of aneurysms treated at the Louisville City Hospital for ten years past, there were more than twice as many in negroes as in whites, although the proportion of white to colored patients in this institution has been nearly 3 : 1.

[1] "The Malignant Tumors of Infancy, Childhood, and Youth," London *Lancet*, May 1, 1897.

Age also has a most direct bearing, as aneurysm rarely occurs before thirty. In the series analyzed by myself, none occurred under twenty-five; there were but 3 under thirty, aged twenty-five, twenty-eight, and twenty-eight, respectively.

The greatest number of cases will be found between thirty-five and fifty-five. The disease is rare after sixty.

Aneurysm, apparently, is far more common in some races than in others, being very frequent and seemingly increasing in England; while it is one of the rarest affections in China, due, it is said, to the non-stimulating rice-diet, temperate habits, and phlegmatic temperament of the Chinese.

Hunter McGuire, of Richmond, Virginia, states that "aneurysm is much more common in the negro than in the white, in my experience." Tiffany, of Baltimore, writes of the frequency with which aneurysm occurs in the black race. Nearly all surgeons from whom replies have been received to my inquiries have remarked upon the greater liability of the black race to aneurysm. These statements, however, are merely impressions gained from a large experience, but not substantiated by statistics. It is certainly my own conviction that aneurysm is relatively far more common in the negro; and therefore I cannot agree with Matas, when he states that aneurysms are somewhat less common in the African, on account, as he thinks, of their comparative immunity to gout, rheumatism, and alcoholism.

FIG. 402.—Case of fibroma molluscum in a white man forty-one years of age.

Appendicitis.—That appendicitis is relatively a rare disease with negroes is a fact substantiated by all Louisville surgeons and others who have been interrogated. In an analysis of 250 cases operated upon by Louisville surgeons, but 5 cases have been reported in negroes. This would indicate a striking immunity, as it shows the disease to be only one-tenth as common in the black as in the white race.

Age.—The influence of age is not less marked than that of race. The disease is most common between fifteen and thirty-five. Though Holt, Villard, and others report cases under five years of age, but few are of record; and we are justified in saying that the first quinquennium of life enjoys a practical exemption from this affection. It is rare in the second quinquennium, more common in the third; the liability further increases in the fourth, and reaches the maximum in the fifth quinquennial period; it then declines slowly in the sixth, seventh, and eight, to

become thereafter a rare disease. I have analyzed 92 cases with reference to age, and find there were:

Under 5 years	. . . .	1 case (3¾ years).
5 to 10 years	. . . .	9 cases.
10 to 15 "	. . . .	11 "
15 to 20 "	. . . .	18 "
20 to 25 "	. . . .	19 "
25 to 30 "	. . . .	16 "
30 to 35 "	. . . .	4 "
35 to 40 "	. . . .	4 "
40 to 45 "	. . . .	5 "
45 to 50 "	. . . .	2 "
50 to 55 "	. . . .	3 " (51, 52, and 53 years).
		92 cases.

Average age . . . . 23.12 years.

In Fowler's 169 cases,[1] the age of the youngest was two and a half years; the oldest, sixty-eight. In the youngest case, the disease was tubercular in character This was the only case occurring under five years of age.

Between 5 and 10 years	. . . .	8 cases.
" 10 and 15 "	. . . .	21 "
" 15 and 20 "	. . . .	29 "
" 20 and 25 "	. . . .	43 "
" 25 and 30 "	. . . .	23 "
" 30 and 40 "	. . . .	28 "
Over 40 years	. . . .	16 "

Congenital Deformities.—Harelip, cleft-palate, club-foot, spina bifida, and all congenital deformities are certainly less frequent in the negro.

Club-foot and spina bifida in the negro have never been encountered in my practice; nor, so far as I can learn, in the practice of other Louisville surgeons.

Congenital deformities of all kinds are also reported to be rare with Indians. The only deformity reported by any of the many army surgeons interrogated was 1 case of club-foot and 1 of double harelip, both in Sioux children, reported by Major William L. Kneedler, of the United States Army. Other army surgeons have stated that they never met with these deformities in Indians; most of them, however, stating that they may not be so rare as their observations would indicate, for it is the custom of Indians to put deformed children to death soon after birth.

The Mexicans, as a race, suffer more frequently than Indians from all congenital deformities; and a number of cases of harelip, clubfoot, supernumerary digits, and like deformities have been reported to me.

Jews, it would seem, suffer infrequently from congenital deformities.

Enlarged Prostate.—My own experience leads me to believe that enlargement of the prostate, as a senescent change, is common enough in the white after fifty; but that it is rarely seen in the negro. Every surgeon to whom I have written expresses the same opinion, many stating that they have never seen it in the full black.

[1] *Annals of Surgery*, May, 1894.

Hunter McGuire writes me as follows: "As much as I have had to do with this subject, I never saw a case of chronic hypertrophy of the prostate gland in a pure negro; I see it very often in the mulatto and mixed breeds."

John P. Bryson, of St. Louis, writes that while he often sees tuberculosis of the prostate and testicle in the negro, he has never seen a single case of prostatic hypertrophy; nor do the records of the college and hospitals of St. Louis with which he is connected show a single instance of this affection.

P. S. Conner, of Cincinnati, writes that "Enlarged prostate is infrequently found in blacks."

F. C. Leber, who was president of the Louisville Board of Examiners of Pensioners, says that in his four years' service no case of enlarged prostate in the negro presented for examination. He has not seen it in private or hospital practice in thirty-seven years' experience.

Other Louisville surgeons have never seen enlarged prostate in the negro, notwithstanding the fact that the negro population is 1 : 4, and our clinics are made up almost entirely from the negro population.

I have seen 1 case in a negro past eighty in twenty years' experience.

The records of the Louisville City Hospital for the past ten years have been most carefully examined, and not a single case occurring in the negro has been found.

I therefore agree with Matas, that chronic enlargement of the prostate gland is a rare disease in hospital practice in Louisville, as it is in New Orleans; but cannot agree with him that it is relatively nearly twice as common in the black race.

Age.—Of course, age has a most important bearing upon enlarged prostate; and it is practically never seen before middle life. It is said by most authors that about one-third of all males past middle life are subject to some enlargement of the prostate; in only about one-tenth of these, however, is the enlargement of such nature as to be of pathological import. I am sure that I have never seen enlarged prostate, not clearly due to malignant disease, prior to fifty, and few cases under sixty.

White and Martin state that prostatic enlargement occurs, as a rule, in men who have passed the age of fifty-five; and that, "on the basis of extensive tabulations, it is, however, apparent that enlargement of the prostate begins only exceptionally under the age of fifty or after that of seventy." [1]

Erysipelas.—The total number of deaths from erysipelas in the United States Census Report just issued was 2663. The death-rate per 100,000 inhabitants was as follows:

Under 5 years	31.34
5 to 15 years	0.81
15 to 45 "	2.80
45 to 65 "	8.88

Few cases were reported as occurring in the negro.

A careful examination of the records of the City Hospital and the Louisville Health Office shows that the disease is not so rare in the negro as many suppose. Of 79 deaths due to erysipelas reported to the Health Department in the past ten years, 17 were colored, which is about the normal proportion, our population being 1 : 4.

Those unaccustomed to seeing erysipelas in the negro easily overlook it on account of the color of the skin.

The two extremes of life suffer by far most frequently, young adults and middle-aged persons having it but rarely; and when they do, being predisposed to it, as a rule, by Bright's disease, diabetes, and alcoholism.

Gall-stones.—Gall-stones practically never occur during the first

[1] *Proc. Amer. Med. Assoc.*, 1898; author's address, Section on Surgery.

decade of life, and but rarely in the second. It may safely be said that they are infrequently seen prior to thirty. Afterward, they become progressively more common with advancing years. In more than 9000 autopsies gall-stones were found in 1 case in every 30 by Naunyn; in persons past sixty, 1 out of every 6 is affected (Naunyn). That the colored race is far less frequently affected than the white seems certain. Of 106 cases operated upon by Louisville surgeons, but 1 was in a negro.

Further, Solomon, curator of the City Hospital, has kept a record of every post-mortem examination since he became curator (two years), and in not a single instance have stones been found in the gall-bladder of a negro. It was examined, of course, in every case. He found them frequently in whites.

That the negro should suffer less frequently is, I think, explained by their more active life, better teeth, and stronger digestion, coupled with the fact that they do not indulge in the highly seasoned food of the whites; they are also less liable to malaria and other conditions dependent upon, or associated with, a torpid liver.

Acute Intestinal Obstruction.—Omitting congenital malformations as a cause of obstruction, we have, first, invagination or intussusception; secondly, impaction of foreign bodies, notably gall-stones; thirdly, volvulus, or twisting of the bowel upon its axis, said to be due to elongation of the mesenteric attachment of the gut; and, fourthly, internal strangulation, due either to an inflammatory band, a Meckel's diverticulum, or a protrusion of the gut through an internal opening.

I have chosen to consider only acute obstruction, as it would seem to have a more direct bearing upon the questions of age and race.

Intussusception.—Intussusception causes at least one-third of all cases of acute intestinal obstruction. According to W. Brinton, who analyzed 12,000 post-mortem examinations, intussusception causes about 43 per cent. of all cases. Leichtenstern and Fitz place the figures at 38 per cent.; others place them as low as 30 per cent. Intussusception is pre-eminently an affection of infancy and early childhood. L. Emmett Holt has collected 385 cases of intussusception in young children: 141 were under six months old; 89 between six and twelve months; 32 between the first and second years; 96 between two and ten years. It will be seen that considerably more than one-half of these cases occurred within the first year. At least one-half of all cases of intussusception occur at the ileocecal junction. Of the remaining cases, twice as many will occur in the small intestine as in the colon.

Impaction of Foreign Bodies.—Foreign bodies, hardened feces, and especially gall-stones, occasionally cause intestinal obstruction; and from statistics it would seem that this will explain about 1 case in 15 of intestinal obstruction. Occasionally, an instance will be met with in a child who has swallowed foreign bodies. Cases due to fecal impaction are usually in elderly subjects, a decided preponderance being females.

Volvulus.—Intestinal obstruction due to volvulus is comparatively rare. It nearly always occurs after middle life, frequently in elderly people, and is three or four times as common in *men* as in *women*. Elongation of the mesentery, which is supposed to act as a cause, may be congenital; but is usually exaggerated late in life as a result of pro-

longed traction, therefore explaining the relative frequency of this affection in elderly subjects, just as hernia is accounted for in the same way.

Internal Strangulation.—This variety of intestinal obstruction is the most frequent of all. It may be caused by a Meckel's diverticulum, inflammatory bands, retroperitoneal herniæ, prolapse of the intestine into an abnormal pouch, or it may be a form of internal hernia. As intussusception is closely identified with the first decennial period of life, and volvulus with elderly subjects, this variety is associated with individuals between the two extremes of life. This is, as we might expect, on account of occupation, exposure, and the diseases to which we are liable during the active period of existence. In men it may follow appendicitis caused by a band constricting the bowel; in women it not infrequently follows pelvic inflammation.

Race.—Of 45 fatal cases of intestinal obstruction reported to the Louisville Health Office for the past ten years, 40 were white and 5 colored. This would indicate a mortality in the white race exactly double that in the black, the normal population being 1 : 4.

Ovarian Growths.—Ovarian tumors, cystic and solid, occur in all ages and in every race. The more usual form of growth is cystic in character, simple or dermoid. Both varieties may be congenital, and then only await the stimulation that puberty brings to awaken them into renewed activity. Therefore, although there are many instances of operations upon simple and dermoid cysts in children, we may say that prior to puberty ovarian growths are relatively rare.

An infant four months old was successfully operated upon by D'Arcy Power for an ovarian cyst. Hoffman reports an unsuccessful case at three months, the tumor weighing 10 pounds. Busch operated unsuccessfully upon an ovarian cyst in a child twenty-four months old. De Santa Anna removed a dermoid cyst in a child one year old, and Roehmer one from a child twenty months old, and Schwartz one from a child four years old.

Mears, Barker, and Rein have operated in cases of children under seven years of age; while Thornton, Lucas, Hamaker, Cupples, and Chenoweth have operated in children from seven to seven and one-half years old. Sir Spencer Wells and many others report operations in children under ten years of age.

As to the other extreme of life, the same may be said, not even the octogenarian being immune. A great many cases have been reported in women past seventy, and a number were in subjects eighty and beyond.

Cartledge, of Louisville, recently operated successfully upon a case past eighty-one; Homans reports a case at eighty-two. But while it is true that ovarian cysts may, and do, present themselves at any age, it is also true that they are most likely to develop during the sexual life of the host. Puberty stimulates not a few to a rapid growth, especially dermoids; therefore it is not unusual to find such growths under twenty. They and all other ovarian tumors are more common, however, during the next three decades of life.

Cystic disease of the ovary is unquestionably less common in the negro; but the difference in liability of the two races which is supposed by many surgeons to exist, is not supported by accurate statistical data. A large number of ovarian cysts in negroes—full-bloods as well as mulattoes—have been reported by various surgeons of the South.

The records of the Health Office of the City of Louisville show that there have been nearly one-third as many deaths from ovarian tumors in the colored race as in the white during the past ten years. This would indicate that they are even more common than in the white, as the normal proportion of colored to white population is 1 : 4; yet this is not the case, I think, as the discrepancy is easily explained in several ways:

In the first place, the colored race is less resistant to surgery of all kinds, a fact which seems clearly established by Matas, from the enormous experience of the Charity Hospital of New Orleans. In the second place, negroes are oftentimes operated upon by less skilled abdominal surgeons and under environments less advantageous than whites enjoy. Finally, I am satisfied that the immunity which the negro is thought by many to enjoy does not exist except to a limited degree, if at all ; for if they were immune at one time, the immunity hitherto enjoyed has, like that from malaria and yellow fever, almost wholly disappeared.

Malignant disease (usually sarcoma) of the ovary may occur. It is four times as common before the age of fifteen as afterward. Twenty-five per cent. die from operative interference, and nearly all within a year from recurrence. Moreover, convalescence is tedious in those who survive operation.

Rectal Diseases.—That all periods of life do not suffer equally from the several diseases of the rectum is apparent to every observant practitioner. Children frequently have prolapsus ani and polypi, but rarely other rectal affections. Elderly persons also enjoy a relative immunity from rectal disorders, and suffer infrequently from the more common troubles—hemorrhoids and fistula. Carcinoma is more frequent with them ; but even this is, comparatively speaking, a rare disease.

Middle life is the time when piles, ischiorectal abscesses, fistulæ, and fissures are most prone to occur. They are all frequent.

An analysis of 70 cases of hemorrhoids shows only 3 patients under twenty to have suffered—at the ages of fourteen, eighteen, and nineteen years, respectively. Fourteen suffered in the third decennium ; 15 in the fourth decennium ; 19 in the fifth decennium ; 19 in the sixth decennium, and 3 in the seventh decennium.

Race has a marked influence, there having been 60 whites to 10 colored. As these were hospital cases, where the proportion of colored to white patients was about 1 : 3, piles seem to be more than twice as common in the white.

Hemorrhoids are said by army surgeons and others to be rare among the North American Indians. The celebrated authority Van Buren, who spent some years among them, stated that he never saw a case of piles in an Indian.

F. A. Winter, Assistant Surgeon, U. S. A., informs me that hemorrhoids are reported to be common with Mexicans, and their liability is supposed to be due to the free use of mescal. Piles are common with the Mexicans of New Mexico, where pulque is not used as a beverage ; and is supposed, by nearly all of the practitioners of this territory, to be due to the free eating of cayenne pepper.

I am told by careful observers with extensive practice among Jews, that they are, as a race, liable to rectal affections. Gerster, of New York, for many years surgeon to Mt. Sinai Hospital, in which patients are mostly Hebrews, has stated, in a paper read before the American Surgical Association, that this race frequently suffers from rectal affections.

Fistula in ano is equally as common, or nearly so, in the colored race as in the white. An analysis of 43 hospital cases shows 33 in white, 10 in negroes ; normal proportion of colored to white nearly 1 : 3. The liability of the negro to tuberculosis explains his being more frequently affected with fistula than with piles.

Age.—The first decade, as in piles, furnished no cases ; the second, but 5 cases, aged thirteen, sixteen, seventeen, eighteen, and nineteen

years, respectively. The third decennium furnished 12 cases; the fourth, 10; the fifth, 4; the sixth, 11; the seventh, 2.

Fistula is undoubtedly more fatal in the colored race. Of the fatal cases reported to the Louisville Health Office during the past ten years, there were nearly twice as many deaths in negroes, although the normal proportion of colored to white population is only 1 : 4. This would indicate that fistula in the negro is nearly eight times as fatal as in the white.

The excessive mortality in the colored race can be explained by their greater tendency to tuberculosis, sepsis, and syphilis.

Stone in the Bladder.—Johnston, of Richmond, Va., has made a careful investigation of 1068 cases of urinary calculi occurring in twelve Southern States, and finds that the negro is less immune to this affection than has hitherto been believed by many surgeons. It occurs once in every 11,732 whites; and in the black race, once in 55,305. It is then nearly five times (4.72) more frequent in the Caucasian.

Gross analyzed 6042 cases of urinary calculi with reference to age, and found that:

From the first to the tenth year, 2334 occurred; 1079 from the tenth to the twentieth year; 513 from the tenth to the thirtieth year; 353 from the thirtieth to the fortieth year; 422 from the fortieth to the fiftieth year; 536 from the fiftieth to the sixtieth year; 587 from the sixtieth to the seventieth year; 201 from the seventieth to the eightieth year; and 17 from the eightieth to the ninetieth year.

It will be seen that more than one-half of all cases occurred within the first two decades of life, and that the first furnishes more than double as many cases as the second, and the latter more than double the number in the third decade; the ratio is then pretty well maintained until the sixth decade, when an increase is noted; this increase to be still further augmented in the seventh decade.

When it is remembered that there are relatively fewer persons living in the sixth and seventh decades, it will at once be seen that the two extremes of life, the first and seventh decades, respectively, are most obnoxious to urinary calculi.

Stone in the bladder occurs everywhere, affecting every race; but it is found in some countries more frequently than in others. In North America, it is found most frequently in Kentucky, Tennessee, Ohio, Missouri, North and South Carolina, Virginia, and Georgia. New England is relatively exempt, as are also Mississippi, Alabama, Louisiana, and a few other Southern States.

Stone is common in France, Austria, Hungary, and Russia, and seldom seen in Spain and Switzerland. It is also frequent in England, though less so in Ireland. It is very common in India. In China, gravel and calculus are, according to Gudgeon, of Pekin, among the rarest of affections. Stones are common at Canton, but of infrequent occurrence at other points. It has been supposed to be due to the fact that the inhabitants here live largely upon fish; but this can hardly be, as Gudgeon states that the diet, water, and habits are the same here as at other Chinese centers.

Opium-eating is supposed to lessen the liability of the Chinese, as a race, to stone. Certainly it is not the drinking of limestone-water, as

river-water is universally drunk, and very generally boiled before drinking. Little cold water is drunk in China.

A number of surgeons in the medical corps of the United States Army assure me that stones in the bladder and kidney are rare among the North American Indians; and the reported cases will generally be found to have occurred as a result of traumatism, a nucleus in the bladder inviting the deposition around it of the solid constituents of the urine.

I have reports which justify me in stating that vesical calculi are more common with Mexicans, one operator in the small town of Santa Fé reporting 5 operative cases.

Stone in the Kidney.—Practically all that has been said of vesical calculus applies with equal force to the renal variety.

Tetanus.—While tetanus is coextensive with civilization, affecting every race and clime, it is more common in subjects living in hot climates and possessed of dark skins. Negroes, Hindus, South Sea Islanders, Italians, Spanish, and French are less resistant to the germ of Nicolaier. In this country the negro is unquestionably more liable than the white, the infant mortality being heaviest. Appreciating the indifference with which negroes treat minor injuries, and their proverbial uncleanliness, we can well understand their greater liability to infection.

The mortality among colored infants is particularly high in comparison with the white, which is explained by racial predisposition, on the one hand, perhaps, and by the greater chance for infection through the cord of the newborn, cut as it is with dirty scissors, handled with dirtier hands, and wrapped in unclean rags. A large per cent. of colored infants on Southern plantations die from trismus neonatorum, death usually occurring within a fortnight after birth. In the island of Jamaica and other more southern countries, the death-rate is at times frightful, being from one-quarter to one-half of all infants born; yet the whites here do not suffer to any degree.

According to the Eleventh Census, there were 2019 deaths from tetanus in the census year. Persons from five to fifteen years show the highest death-rate, 1.74; those from 15 to 45, 1.04; and over 45, 1.42.

There were 60 deaths in Chicago during the month of July, 1881, due to toy-pistol accidents. This, I think, explains the greater number of cases in young subjects. They meet with more accidents and are careless in the treatment of their wounds.

Tetanus is frequently encountered in military practice. English soldiers in Spain suffered from tetanus in proportion of 1 : 80 wounded; and in the East Indies, in 1872, twice as often.

During the Civil War our troops were more fortunate. Surgeon-Major J. C. Merrill, U. S. Army, Librarian of the Surgeon-General's Office, states that out of 246,712 injuries by weapons of war, 505 (0.20 per cent., or a little over 2 in 1000) were followed by tetanus.

The Italians, Spanish, and French have suffered more in their wars than soldiers of more northern countries, with fairer skins.

I am informed by Hebrew surgeons that trismus neonatorum is more common than it should be in Jewish infants. It can well be

explained by the manner of performing the ritual circumcision. The Mohel is necessarily surgically unclean and careless in performing the operation, and infection must be more frequent than if this function were transferred to surgical hands.

Tuberculosis of the Bones, Joints, Serous Membranes, and Glands.—Pulmonary consumption, which was practically unknown to the Africans and Indians of North America several generations ago, is now their deadliest foe. It is more than twice as common in the African than in the white, and still more prevalent with the Indian, the latter race suffering directly in proportion as they give up their tepee life and live in poorly ventilated buildings. Therefore, it is not surprising that local tuberculosis of the bones, joints, lymphatic glands, and serous membranes should show the same proportion of cases in the three races.

I am informed by reliable observers in the Medical Corps of the Army and Indian Departments that an enormous per cent. of Indian boys and girls develop one or more varieties of surgical tuberculosis when they give up their outdoor life for the schoolroom. Tuberculosis

FIG. 403.—Tubercular glands of the neck in a young negro.

in all of its manifestations has increased with the Mexican in the same ratio as with the Indians.

Age has a distinct influence, and a majority of such cases occur in the first decennium; about one-fourth in the second; and the remainder after twenty.

Varicocele.—This disease is closely associated with the evolution of the sexual apparatus; and is therefore largely encountered in adolescence. In my own series of 222 operative cases, and many others not so treated, I have never found it to begin before puberty, and rarely after thirty. The immense preponderance of cases will be met with in the decennium from fifteen to twenty-five. Occurring, as it generally does, in youths who have not begun a sexual life, it is, as a rule, cured

by marriage, unless of long standing and accompanied with atrophy of the testicles. While relatively rare in married men, I have operated within the last year upon 4 such cases in men aged twenty-four, thirty, thirty-five, and fifty-seven, respectively, the last being older than any other case in my series; in fact, his was the only instance of the disease I have seen past forty.

Negroes are practically immune to varicocele. It has been frequently observed that this race enjoys a relative immunity to varices in general. Varicose veins of the legs, and hemorrhoids, are noticeably less common in the negro; still, a number of such cases have come under my observation. In an analysis of more than 600 cases treated and operated upon by Louisville surgeons, not a single case has been seen in the full-blooded negro, and only 1 encountered in a mulatto. The records of the four large dispensary services of Louisville do not furnish a single case of varicocele in a negro, notwithstanding the fact that nine-tenths of the patients are colored. Correspondence with surgeons and clinical teachers of other cities has almost invariably been followed by the statement, " Have not seen varicocele in negroes."[1]

There are good reasons, anatomical and physiological, for the negro's immunity: The testicles do not hang so low as in the white, are not so large, though the penis is larger, and the scrotum is close fitting and less lax than in the white man, giving a better support to the veins of the pampiniform plexus. In the negro the condition is much like the scrotum of the dog.

Physiologically, the negro begins his sexual life at puberty, and is never continent thereafter.

Varicocele is rare in those who functionate regularly. It is reported to be uncommon in Indians.

Varicose Veins.—Varices of the limbs are but seldom encountered in negroes. Of 23 cases of varicose veins of the legs without ulcer, there was but a single case in a negro, a man aged forty-four. Of 22 varicose ulcers, there was only 1 case in a negro, a man aged fifty-three.

Varicose veins are rare before thirty, there being but 2 in the series, aged twenty-seven and twenty-eight, respectively. Between thirty and forty there were 4 cases; forty and fifty, 4 cases; fifty and sixty, 6 cases; sixty and seventy, 7 cases; and seventy and eighty, 2 cases.

Varicose veins of the limbs are uncommon with Indians Mexicans, and Chinese.

[1] See author's address, *Proc. Amer. Med. Assoc.*, 1898, Section on Surgery. Since the above was written I have operated upon a case of well-marked varicocele in a full-blooded negro, twenty-two years of age, who claims to have led a strictly continent life.

CHAPTER XXV.

GONORRHEA.

GONORRHEA is a suppurative disease of the tissues of the human body, caused by infection with the micrococcus of Neisser, or the gonococcus. It always is primary in mucous membranes; but, secondarily, it may attack serous membranes and fibrous tissue—synovial sacs, bursæ, tendon-sheaths, the peritoneum, pleuræ, and pericardium.

In many cases the infection is a mixed infection of gonococci and pus-organisms. The term gonorrhea, used without qualification, means a specific inflammation of some portion of the genito-urinary tract from infection with gonococci by sexual intercourse. Gonorrhea may, however, be acquired in other ways—by instrumentation, by use of infected towels, etc.; and may occur on mucous membranes in other parts of the body—the rectum, nose, throat and mouth, and eye. These unusual regions may be infected by contact with dirty fingers, instruments, etc., or by perverted sexual acts. Gonorrhea in the male sex commonly means a suppurative urethritis from sexual infection. (For Bacteriology, see Vol. I, p. 33.)

Diagnosis.—The diagnosis of gonorrhea should only be made positively when gonococci have been found, with their characteristic peculiarities of staining, location in cells, etc. Most cases of profuse urethral discharge coming on after a suspicious connection present no doubtful features; but in certain cases of slight discharge of long standing or short incubation, in which the sexual or marital history cannot be depended upon, the diagnosis may be difficult, and may involve large responsibility.

Until recent years, it was the fashion to regard many cases of atypical urethral discharge as non-gonorrheal. The practice of most men at the present time is to be very careful in deciding that any urethritis is due to other causes than infection with gonococci.

Urethritis and urethral discharge may, it is true, result from other causes. They may be caused by the trauma of injury or instrumentation; by the excretion of irritating ingesta or the passage of calculi; by prolonged sexual excitement or masturbation. They may occasionally, though rarely, be found as complications of rheumatism or gout, of typhoid fever, diabetes, mumps with orchitis, lead-poisoning, and genito-urinary tuberculosis. A cause of urethral discharge that should always be considered is the presence of a syphilitic chancre within the urethra. In these conditions the history, the associated disease or injury, and the failure to find gonococci will make the diagnosis of a non-gonorrheal urethritis.

The vast majority of cases of urethritis hitherto regarded as due to irritating discharges in the female are undoubtedly due to infection with gonococci. It is certain that gonococci may be latent for months and years in the follicles and glands of the cervix, female urethra, or vagina, and in the follicles and crypts of the male urethra. Urethral discharge after sexual connection is, in all probability, caused by infection with gonococci latent in some part of the female passages or by auto-infection by germs long latent in the male parts after a supposedly cured gleet. No case should be pronounced non-gonorrheal until it has been studied with care and for some period of time.

When pus from an acute or chronic urethritis is examined, and diplococci in any numbers are found in the protoplasm of the leukocytes and epithelial cells, which germs lose their color by Gram's method of staining, the infection is surely gonorrheal.

In some cases an element of doubt may exist. There are undoubtedly diplococci which are non-specific, the " pseudo-gonococci "; but they are rare, are always few in number, and are usually associated with an excess of other micro-organisms.

The diagnosis must always rest on both clinical and bacteriological evidence. We may have:

a. Acute gonorrheal urethritis primary, from direct infection from the female, characterized by severe inflammation appearing in from three to seven days after intercourse, gonococci being present in the discharge.

b. Secondary gonorrheal infection, or auto-infection from gonococci latent in the urethral recesses in cases of uncured or supposedly cured chronic urethritis. This is the lighting up of the old process by intercourse, excessive or otherwise, with or without alcoholic excess. The discharge and inflammation appear in from twenty-four to thirty-six hours after intercourse, and gonococci are present.

c. Urethral suppuration from non-specific causes, from contact with irritating uterine discharges, from gout, tuberculosis, etc.; in this form no gonococci, but pus-organisms, are found.

Men differ in their susceptibility to gonorrheal infection. Not every connection with a diseased woman conveys gonorrhea. There are undoubtedly conditions of immunity, natural or acquired, varying with the individual and with the conditions of health in the same individual, which render some men safer than others in impure intercourse.

Pathology.—Any mucous membrane may be infected primarily; but that which is lined with cylindrical-cell epithelium is most readily involved. Pavement-epithelium seems less susceptible to the infection.

The infected mucous membrane becomes inflamed, swollen, and red, with desquamation of the epithelial cells. Pus-organisms, either already within the urethra or finding speedy entrance, render the infection a mixed one. The germs rapidly invade the mucous membrane and the submucous tissues. In many cases the process is limited to the penile urethra, but in a larger number it extends to the deep urethra, bladder, and seminal vesicles. Extension of the infection to the ureters and kidneys is not common, but does occur. The infection may spread to surrounding tissues by direct extension in continuity, it may be conveyed by the lymphatics to neighboring or remote glands, it may be carried to serous membranes or fibrous tissues by the blood-current, thus causing metastatic infection of the joints, tendons, pleuræ, pericardium, peritoneum, etc. The follicles and the glands which open into the urethra are frequently involved; and it is noteworthy clinically that in these the gonococci often remain latent for months, or perhaps years, after the urethritis or gleet is supposedly cured, and may be the cause of infection, or reinfection, at some remote time. The discharge in acute gonorrhea is made up chiefly of pus-cells and desquamated epithelial cells with swollen nuclei.

The Clinical Course.—Acute gonorrhea begins as an acute inflammation of the anterior or penile urethra. The course of an uncomplicated case of acute anterior urethritis may be divided into three stages:

1. The Stage of Incubation.—This is from three to five days in fresh cases. In cases which have had previous attacks the incubation-stage may be shorter—one to two days. Longer periods of incubation than five to seven days should rouse the suspicion of some other cause for the urethritis than gonorrhea. Sooner or later during the incubation-period, a tickling, itching, or burning sensation around the meatus is noted, followed by scalding on urination; the lips of the meatus are gummed or stuck together. These symptoms inaugurate

2. The Acute Stage.—A feeling of general malaise and some slight fever may be associated with the prodromal symptoms. The local conditions rapidly become acute; painful micturition is a prominent symptom; the purulent discharge from the urethra becomes thick and profuse

and contains many gonococci. Swelling of the glans penis and prepuce is present. In a small number of cases retention of urine, due to swelling of the mucous membrane or to reflex muscular spasm, may be present; extension of the inflammation from the urethral submucosa into the surrounding tissues of the corpus spongiosum is a usual occurrence; the whole penis is congested, swollen, and tender. Sexual excitement is common and erections frequent. These are painful because the engorged and infiltrated corpus spongiosum and urethra, being put on the stretch, bend the penis downward. This painful erection is called *chordee*, and is most frequent and annoying at night.

3. The Stage of Decline.—The acute stage persists from ten days to three weeks. Usually, at the end of two to three weeks from the outset of the symptoms the stage of decline or subsidence begins: the discharge gradually lessens and becomes thinner; the ardor urinæ and painful erections disappear. The discharge may, however, persist for several weeks after pain and painful micturition have ceased.

The above is the course of an acute gonorrhea limited to the penile urethra without complications. In nearly every case of gonorrhea, however, the process is not limited to the penile urethra, but complications, due to extension of the infection and varying in every case, are most important features of the disease. It is a mistake to consider gonorrhea as confined to the anterior urethra; when it invades deeper tissues, as it does frequently, it merits serious consideration.

Complications.—The complications of acute anterior urethritis are numerous. The most important is extension of the infection to the deep urethra, causing a posterior urethritis, with its own special complications. Before considering this, however, it may be well to take up some other and less serious complications of anterior urethritis. Balanitis, phimosis and paraphimosis, warts on the glans and prepuce, and chordee are considered in Chapter XVII. Retention of urine has been mentioned as a possible, though uncommon, complication.

Folliculitis and Peri-urethral Suppuration.—The follicles of the urethra are more or less involved by the suppurative process in every case, and can frequently be felt as tender, shot-like bodies along the urethra near the frenum. These distended follicles, may discharge into the urethra or externally. If those situated in the deeper portions of the penile urethra rupture externally, they may set up a phlegmonous inflammation of the tissues external to the urethra, and be the cause of a peri-urethral abscess. This peri-urethral suppuration may be the starting-point of extensive inflammation, with infiltration of the entire penis; and is often the cause of urinary fistulæ. The signs of peri-urethral infiltration are pain and swelling, with redness—the usual clinical picture of localized suppuration.

Bubo.—Frequently, the inguinal glands are somewhat swollen and tender from an attack of acute anterior urethritis. In a few cases abscess of these glands may result.

Deep Posterior Urethritis.—Acute posterior urethritis occurs in the great majority of cases of gonorrhea, whether the anterior urethritis has been treated or not. It usually appears in the third week of the acute process. It may occur earlier, even when injections have not been used. It is not unusual to find posterior urethritis in the first or second week of the disease. Extension of the inflammation to the deeper urethra

and neck of the bladder is by simple continuity and also along the lymphatics. Early infection of the deep parts may be caused by forcing the germ-laden pus back past the cut-off muscle by injections or by the passage of instruments.

Late infection of the deep urethra may be caused by excess in sexual intercourse or alcohol during convalescence from a simple anterior urethritis. It is said that horseback- or bicycle-riding predisposes to extension of the infection.

The chief *symptom* of the extension of the disease to the deep urethra is marked increase in frequency of micturition. The desire to urinate is almost constant, although at each attempt only a small amount, and often but a few drops, of urine are passed. This frequent urination is attended with great pain, and at times there is great difficulty in expelling the urine. Blood is frequently passed with the urine or at the close of the act of urination. The congestion of the prostatic urethra causes prolonged erections, which, however, are not usually painful; and also frequent nocturnal seminal emissions.

There is a feeling of painful heat and distention in the perineum, rectum, and above the pubis. With the onset of the posterior urethritis, the discharge from the meatus is lessened appreciably. The development of posterior urethritis is always a serious matter; it may prolong the disease for months, and may tend to other complications. Extension of the disease from the prostatic urethra may cause epididymitis and orchitis, vesiculitis, prostatitis and prostatic abscess, and cystitis. The infection may extend up the ureters to the kidneys, although this is rare.

Cowperitis is the specific inflammation of the two large follicles— " Cowper's glands "—situated between the layers of the triangular ligament; it may be the cause of an abscess in the perineum.

Epididymitis, Orchitis, Vesiculitis, Prostatitis, and Cystitis are discussed elsewhere (see Chapters XVII. and XX.).

Treatment of Acute Gonorrhea.—The treatment of acute anterior urethritis should be general and local. The general principles of hygiene, bodily rest, and the exhibition of internal medicine are fully as important in effecting a cure as the use of any local treatment. Complete bodily rest is desirable. Confinement to bed is a good thing to advise, but patients are seldom willing to accept this. The diet must be very light—liquids, mainly milk, and semi-solids, with no meat. Coffee, tea, and all alcoholic drinks and tobacco must be forbidden absolutely. The bowels must be kept open, and large amounts of water drunk. The liquid diet, with free use of pure water and total abandoning of stimulants, is one of the most important conditions of treatment; but in this, as well as in securing freedom from exertion, patients are prone to fail.

The dangerous nature of the urethral discharge must be explained, and the patient must be specially cautioned against conveying the infection to his eyes. He must be carefully instructed in regard to disinfecting his hands, and sterilizing all clothing or dressings by boiling; and in regard to wearing over the penis a bag, made of rubber or cloth, into which the urethral discharge may be received. The habit of retaining a plug of absorbent cotton inside the prepuce should be forbidden, as it tends to dam up the discharge and to cause balanitis. All sexual suggestion or excitement should be scrupulously avoided. Complete rest, catharsis, a milk-diet, and absolute giving up of alcoholic and stimulating drinks are the most important features in the treatment.

The chief uses of internal medication in acute gonorrhea are to produce catharsis; to render the urine bland, and thus diminish ardor urinæ; to reduce the tendency to chordee. The bowels should be kept open with small doses of salines, with the occasional use of calomel in small amounts.

The best diuretic is potassium citrate or acetate, in doses of 20 grains, well diluted with water, after meals. In addition to these simple diuretics, there are various drugs which not only render the urine bland, but are chiefly valuable because of their restrictive action on the urethral discharge: Balsam of copaiba, oleoresin of cubebs, and santal oil, as well as salol and boric acid. Of these, santal oil, in 20-minim doses in capsules, should be given from three to six times a day, if the stomach does not rebel. Copaiba may produce severe gastric disturbance, and in some cases a general erythematous rash. Salol, in doses of 10 grains three times a day, may be given.

The frequent use of hot water as an external application in acute gonorrhea is of the greatest value. Hot sitz baths, as well as the immersion of the penis in hot water frequently, and especially during urination, are to be advised. If this treatment is followed, the ardor urinæ, as well as the painful chordee, is much lessened.

The tendency to chordee at night may be lessened by the use of potassium bromid, 20 grains three times a day, or 30 grains an hour before bedtime. Suppositories of belladonna and opium are effective in preventing chordee; but must be used carefully, because of their tendency to produce constipation.

Local Treatment by Injection or by Irrigation.—By local treatment is meant application to the anterior urethra of antiseptic solutions, either by injection or by prolonged irrigation. At what stage of acute gonorrhea it is wise to begin local treatment is still a disputed point. Some advise the use of irrigation or injections in the earliest days, claiming that by such treatment the duration of the discharge and severity of the disease are lessened, and in certain cases the attack is aborted. Others claim that any such line of procedure is dangerous; and that while it may quickly cut down the discharge, the chance of complications and prolongation of the disease is greater. It can be positively stated that no injections or irrigations given by the patient should be allowed until the acute stage has begun to subside. The only local treatment in the acute stage should be prolonged irrigation carried out by the surgeon. In those cases in which the surgeon can have the patient under care from the beginning, this irrigation method may effect such an astonishingly rapid cessation of discharge and of all symptoms as to justify the use of the term " abortive."

The best irrigating fluid is an aqueous solution of potassium permanganate. For the first week, it should be used in a strength of 1 : 4000. This may be increased in the second week to a strength of 1 : 2000. The best way to irrigate is by means of a soft-rubber catheter, attached by a long rubber tube to an irrigating jar, or fountain-syringe. The jar containing the irrigating fluid should be raised from 3 to 5 feet above the level of the penis. Kiefer's blunt two-flow irrigating nozzle may be used, but is not so efficient as a catheter.

Before irrigation is begun the urine should be passed, and the meatus and glans penis thoroughly washed with an antiseptic solution. The catheter should be covered with glycerin or boroglycerid, and not with oil or vaselin. From 1 to 3 pints of the fluid should be used at each irrigation : no force should be used. This treatment should be carried out daily, in association with the hygienic and medical treatment.

It has been found that in those cases where it is possible to use this irrigation method with care all symptoms rapidly diminish. Various other solutions have been used for irrigating, but the permanganate is the best. In certain cases a thin, mucopurulent discharge, slight in amount, will persist in spite of the permanganate irrigation ; this must be treated by astringent injections.

Local treatment by injections given by the patient himself should never be begun until the acute stage of the urethritis is at an end. Injections should be given with a special blunt-pointed hard-rubber syringe holding about ½ ounce. Careful directions should be given each patient as to how to use the injection. The bladder should be emptied ; no force should be used, but the fluid should be injected slowly. The patient should sit upon a chair-back covered by a folded towel, so that the towel compresses the perineum and membranous urethra and prevents the possible penetration of the fluid farther than the anterior urethra. The injected fluid should be held in the urethra for a full minute.

The various antiseptics and astringents that have been used as local injections are legion. A mild antiseptic and astringent, the strength of which can be gradually increased, is the desideratum. No one chemical is a specific. Some one of the following salts of zinc, either singly or in combination, will be found most useful : Zinc permanganate, 1 : 4000 ; or the acetate, chlorid, or sulphate of zinc, 1 grain to the ounce. The strength of the solutions may be cautiously increased as the discharge lessens in amount and becomes thinner. A solution of silver nitrate, 1 : 4000, and gradually increased to 1 : 2000, or even stronger, may be used ; but the reaction from this is often severe, and the danger of setting up complications—epididymitis, etc.—greater. Bichlorid of mercury or carbolic acid, in very weak solutions, may be combined with some one of the zinc salts, if desired.

Under such general and local treatment many cases of acute gonorrhea will be cured in from four to seven weeks. The persistence of pus-shreds in the urine, and gluing together of the meatus, especially in the morning, will point to the existence of a chronic process in some portion of the urethra.

Treatment of Acute Posterior Urethritis.—At the first sign of the extension of the acute process to the deep urethra all injections or irrigations should be stopped. The patient should be treated by rest in bed, hot fomentations, and sitz baths ; vesical tenesmus and painful urination may be relieved by hot or cold rectal douches and suppositories. No local treatment of the deep urethra should be attempted until the acute symptoms have subsided.

Acute epididymitis, prostatitis and cystitis, and vesiculitis are not infrequent complications of acute infection of the posterior urethra. Their treatment is discussed in Chapters XVII. and XX.

The **treatment of folliculitis and peri-urethral suppuration** is that of localized inflammation and suppuration. The stage of brawny infiltration is best treated by heat, immersing the penis in hot water or applying hot antiseptic compresses. When pus is evident, it should be

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thoroughly evacuated and the phlegmonous condition treated antiseptically.

Phimosis, paraphimosis, and *balanitis* occur in acute gonorrhea. The best treatment for these conditions is prolonged immersion of the penis in hot antiseptic solutions—corrosive sublimate, 1 : 10,000, or creolin, 1 : 400.

Chronic Urethritis.—When a urethral discharge has persisted for eight or nine weeks it is called chronic. Urethritis may become chronic through ill-advised or neglected treatment, because of the localization of the infection in one or more of the follicles, glands, or recesses of the urethra. The term gleet is often used synonymously with chronic urethritis : as properly used, the term means the discharge in chronic urethritis, and not the disease itself.

Chronic urethritis is the persistence of a discharge caused by the existence of one or more spots of ulceration somewhere in the course of the urethra. These localities are in and around one or more of the urethral follicles—the glands of Littre.

Chronic anterior urethritis is due to the existence of the diseased patches anywhere in the pendulous urethra, the most common site being in the bulbous portion. The symptoms are not severe. A mucoid discharge may be noticeable at the meatus during the day, and a distinct "morning drop" of pus. The slight amount of urethral pus accumulates during the night and can be pressed out in the morning. There may be slight increase in the frequency of urination, and the urine will contain shreds of pus, epithelial cells, and mucus—the so-called "clap shreds" or "tripper fäden." In these shreds gonococci can be demonstrated.

Chronic posterior urethritis has for its chief symptoms frequent urination and vesical tenesmus, and is often associated with chronic disease of the prostate and seminal vesicles. Mental depression and neurasthenia are frequent accompaniments of chronic gonorrhea, and the treatment of the imaginary ailments and the mental worry is often a most important feature of these cases.

It is to be noted that a gonorrhea may be chronic in the deep urethra and seminal ducts when no discharge from the meatus, or gleet, exists. It is not uncommon for a chronic posterior urethritis to exist without a discharge from the meatus ; pus may or may not be kept back by the cut-off muscle.

The **treatment** of a chronic urethritis will obviously depend upon the locality of the diseased areas. Plastic exudation into the submucous tissues causes stricture or a narrowing of the caliber of the urethra.

Stricture-formation is a predominant sequel to gonorrhea, and the presence of ulcerating areas behind and at strictures is an obstinate factor in causing chronic urethral discharge (for Stricture, see p. 532). Exploration of the urethra to determine the existence of ulcerations and strictures, and examination of the seminal vesicles by digital palpation, are essentials in the accurate treatment of chronic gonorrhea.

To determine the source of the discharge, whether it comes from the anterior urethra only, what is known as the "three-glass test" is important. After the patient has held his urine for two hours or more, a soft-rubber catheter, anointed with glycerin or boroglycerid,

is passed as far as the bulbous urethra, and the anterior urethra is gently irrigated with boric-acid solution, 2 per cent. This removes the pus and shreds from the anterior urethra. The patient then passes about an ounce of urine into the first glass; this will contain pus from the deep urethra. The prostate and seminal vesicles should be then massaged by the finger passed into the rectum, after which the urine is passed into the second glass, thus giving evidence as to disease of the seminal vesicles and ducts. The rest of the urine is passed into a third and larger glass. If, after washing the anterior urethra and massaging the prostate and ducts, the urine is free from pus-shreds and pus, the disease is local in the anterior urethra.

The use of bulbous steel sounds in the anterior urethra will determine the presence of strictures, and also demonstrate the ulcerating patches. When the sound is withdrawn, touching the granulation-areas will cause pain and perhaps bleeding, even if no appreciable narrowing of the caliber of the urethra exists. If the meatus is too small to admit the larger sizes of the bougies, it may be divided under cocain-anesthesia; or, if this is not done, Otis's urethrometer should be used.

Ocular examination of the entire urethra may be obtained by use of the endoscope. There are several varieties of endoscopes, and their use requires some special training. It is desirable that every case of chronic urethritis be examined and treated with the endoscope. It is the most rational and intelligent method. Many cases, it is true, will be cured without it; but, on the other hand, in certain obstinate cases its use is imperative.

The endoscope devised by Klotz, with Otis's modification and electric attachments, is the best form to use. Klotz endoscopes consist of a straight silver tube, with a flange at the outer end. An obturator is used to facilitate insertion. Through this tube the entire length of the urethra can be examined by means of reflected light thrown in by the head-mirror. Treatment of the diseased areas is by direct application of a strong solution of silver nitrate, 5 to 20 grains to the ounce. Applications should not be made oftener than once a week. The modifications of Otis, which concentrate the rays of an electric lamp and throw them down the tube, are specially valuable.

The most important treatment in any case of gleet is the regular use of steel sounds. These should be introduced the entire length of the urethra every third or fourth day. By this procedure the incipient strictures and granulation-patches are dilated and ironed out. No gleet can be cured unless all strictures are completely dilated. If the meatus is too small to admit the large size sounds, it should be divided. The sounds, as well as all other instruments used in the urethra, should be sterilized by boiling.

Accompanying this regular use of steel sounds, some form of injection or irrigation should be used on one of the intervening days. For the anterior urethra, an injection of silver nitrate, 1 : 2000, or of sulphate or chlorid of zinc, 1 or 2 grains to the ounce, should be used. The strength and frequency of the injections must be governed by the amount and severity of the reaction, pain, and increased discharge.

For chronic posterior urethritis, injections, or rather instillations, of a few drops of silver nitrate, 2 per cent. to 10 per cent., in increasing strength, given by an Ultzmann prostatic syringe, or irrigation of the deep urethra with permanganate, 1 : 4000, or silver nitrate, 1 : 8000, may be used. This irrigation of the deep urethra is best accomplished by passing a sterilized soft-rubber or metal catheter into the prostatic urethra after the patient has passed urine, and injecting slowly with a piston syringe about 3 or 4 ounces of the fluid. The fluid should be held in the bladder as long as possible. The anterior urethra should first be washed out.

Suppuration in the seminal ducts and vesicles is an important complication of chronic posterior urethritis. Digital examination of the structures through the rectum should always be made.

The general hygienic and tonic treatment in chronic urethritis is

important. The nervous condition of many of the cases needs careful study.

Gonorrhea in the Female.—The extent of the infection varies. The vulva and urethra, as well as the cervix uteri, are commonly involved. The vaginal epithelium seems less susceptible to infection with gonococci, but undoubtedly gonorrheal vaginitis does occur. The glands of Bartholin are frequently infected.

The chief complication and danger in gonorrhea in the female is the infection of the uterus and uterine appendages. Gonorrhea is the chief source of salpingitis and pelvic peritonitis, and may cause general peritonitis.

The **treatment** of acute gonorrhea in the female consists in hot antiseptic vaginal douches and sitz baths, and local treatment of the urethra and cervix uteri by application of strong silver nitrate. In addition, general medical treatment, rest, light diet, cathartics, and diuretics should be used.

Gonorrheal Arthritis, or Gonorrheal Rheumatism.—Gonorrheal infection of mucous membranes, whether urethral or elsewhere, may at any time cause acute or subacute inflammation of one or more joints. About 2 to 3 per cent. of the cases of gonorrheal urethritis present the complication. It comes on in the majority of cases affected in the third week of the disease or later, but may appear at any period from two days to three or four months after the primary infection. It most frequently occurs in cases of chronic posterior urethritis. The infection is carried by the blood-current, and may involve serous membranes or fibrous tissues. The knee-joint is most frequently attacked, and after this the elbow and shoulder and the joints of the feet and hands are specially prone to involvement, though any joint may be affected. The inflammation may appear as an acute process, accompanied with chills, fever, and swelling. This form may go on to suppuration and pyemia, though this is rare. The acute form runs a rapid course; the chronic forms last for several years. It is not common to find more than one joint affected. In addition to the joints, the infection may involve fasciæ, bursæ, and the fibrous sheaths of nerves (especially the great sciatic).

The morbid appearance of the joints or fibrous tissues affected presents no characteristic features, save that gonococci may in some cases be demonstrated in the exudate.

The **symptoms** usually resemble those of acute or chronic articular rheumatism. If no history of gonorrhea can be obtained, a differential diagnosis from true rheumatism can only be made by the small number of joints involved, by the absence of marked fever and sweating, and by the tendency of the process to become chronic. Cardiac complications are very rare.

Treatment.—The use of salicylates and other antirheumatic treatment is of absolutely no value. The urethral discharge should be cured by both local and general treatment. Urinary antiseptics, as salol or boric acid, may be given in full doses. The inflamed joints should be treated by rest, splints if necessary, hot fomentations and blisters, or, in the first stages, by ice-bags. In the chronic stages, massage, hot air, and general tonic and supporting treatment, with moderate doses of potassium iodid, are indicated.

CHAPTER XXVI.

SYPHILIS.

Definition, Etiology, and Methods of Infection.—Syphilis is an eminently contagious disease, not infectious in the strict sense of the word, believed to be peculiar to the human subject, and found in every part of the civilized world. The disease is most commonly communicated and acquired during sexual intercourse, when delicate and easily abraded surfaces of different individuals are brought into intimate contact while in a state of great hyperemia and receptivity; hence the name "venereal disease." It must never be forgotten, however, that the disease may be, and very frequently is, acquired in other ways. A medical man, for instance, may accidentally acquire the disease in the discharge of his professional duties. Both medical men and midwives have become infected by attending syphilitic women during childbirth; whole families have been infected by using drinking-cups, spoons, or other articles in common with some infected, often unsuspected, person. Syphilis has been conveyed in the act of kissing from brother to sister, or to other members of a family. Among work-people, such as glassblowers, the use in common of inflating-tubes or other tools has frequently been the means of propagating the disease on an extensive scale.

It is in the highest degree important to bear these facts in mind, so as to recognize syphilis in unusual positions. Medical men have to be constantly on their guard, lest the real nature of a sore be mistaken. A great deal of misery may result from accidental contamination, owing to the highly and protractedly contagious nature of this disease. The abraded surface of a healthy individual brought into contact with the syphilitic virus, no matter where or when, will in all probability become the seat of a primary sore; and the manifold sequelæ which characterize the disease will follow in due course, whether the disease is acquired in impure sexual intercourse or conveyed accidentally to the innocent.

Microbe of Syphilis.—The resemblance in many of its clinical characters to the specific fevers has led to the belief that the essential factor of the disease is a microbe; but though Lustgarten some years ago found and described a bacillus in some cases of syphilis, neither he nor subsequent observers (who are still working at the subject) have been able to establish a definite etiological connection. Lustgarten's bacillus is not constantly present—*i. e.*, it is not constantly found—in syphilitic products; and all attempts to cultivate it have hitherto failed; furthermore, an identical bacillus is said to have been found in other pathological products which are certainly not syphilitic.

Incubation.—Seeing, then, how little we know of the *materies morbi*, it is difficult to speak with precision as to the period of incubation. The average interval between the specific infection and the appearance of the earliest local symptoms varies from two to six weeks,

with a mean of about one month.   During this time the patient remains quite well, and unconscious of the disease which is incubating within him.   This variation in time seems to depend on idiosyncrasy, about which little or nothing is known; a predisposition in some persons undoubtedly plays a prominent part in hastening development.   It is not improbable that the personal factor in this and all other diseases finds its analogy in the bacteriological laboratory in the relative facility with which micro-organisms can be cultivated in various artificial media —the growth in some media being rapid and typical, in others slow and atypical.   As regards syphilis, it is extremely doubtful whether any healthy person adequately exposed to the infection is proof against it.

As syphilis runs a very chronic course, it is usual in describing it to distinguish three stages in the disease: 1. Primary, the initial sore. 2. Secondary, the symptoms which follow during the next two years. 3. Tertiary, the later symptoms.

FIG. 404.—Primary lesion (White).

Primary Syphilis: The Hard Chancre.—The virus having been duly inoculated and having had time to incubate, there appears at the site of inoculation a little inflammatory redness, which quickly becomes a papule; this increases in size, chiefly on the surface, and generally ulcerates superficially.   At about the tenth day we find a more or less circular, sharply defined sore, with a glassy surface, having an elevated border, a depressed center, and an indurated base.   The ulcer is almost painless, and yields a scanty, viscid, serous discharge. This is the "Hunterian," true, or hard chancre.

Induration.—Induration is one of the chief clinical features of such a sore.   Grasped between finger and thumb, the sore will be found to have a hard base as well as a hardened border, both sharply defined and somewhat greater in extent than the sore itself.   The induration varies in amount, possessing a peculiar cartilaginous quality; it is something *sui generis*, and does not seem to stand in any direct relation with

the amount, more or less, of subcutaneous tissue normally present at the site, nor with that of the inflammation, nor with the intensity of the syphilitic virus. The onset in most cases is gradual; it is not found at its maximum until healing is well advanced; in some cases it may persist after healing of the sore is completed. In men induration is seldom absent; in women, however, it does appear to vary, and in a certain number of cases it may be so slight as to be appreciated with difficulty.

Characters of Hard Chancre.—The true chancre is usually single; but many cases of multiple chancre are met with—2 not infrequently, while as many as 19 hard chancres on the same individual at one time are recorded by Ricord. In these latter cases, it is to be presumed that the virus entered the body at several different places, though not necessarily from the same source, about the same time, but before the disease had had time to become generalized. The size of a hard chancre appears to depend in some measure on the size of the original abrasion on which inoculation occurred. The abrasion may be exceedingly small—so insignificant, indeed, as to escape notice. Some authorities teach that inoculation may occur without any abrasion at all. Given a delicate mucous membrane, an adequate supply of infective material, and a sufficiently long contact, there should be no difficulty about inoculation. But, though possible, this mode of inoculation (without abrasion) must be regarded as unusual.

Glandular Enlargement.—Wherever a hard chancre occurs, the nearest lymphatic glands will always be found affected; they gradually begin to swell, and are usually quite painless. Like the chancre itself, these diseased glands are characterized by a specific hardness; hence the term "bullet-bubo," by which name they are sometimes known. The lymphatic vessels proceeding from the sore to the affected glands participate in this induration, and can often be felt beneath the skin like fine cords. The induration develops *pari passu* with the sore; but often persists long after the latter has healed, especially in cases in which the secondary symptoms are going to be well marked. Unless specially irritated, these syphilitic glands rarely suppurate. The persisting induration is sometimes useful in clearing up a diagnosis after a small, ill-marked sore has healed.

Mixed Infection.—In the majority of chancres on the genitals acquired in promiscuous sexual intercourse, along with syphilis, other forms of infective agencies are commonly engrafted; the resulting lesion is thus a compound one, and may vary from the type-form and course within considerable limits. Instead of a hard chancre, pure and simple, we may have to deal with a lesion of a mixed character; with the effects of various contagia, such as pus from soft chancres, from gonorrhea, from balanitis, and from other infective (though not syphilitic) inflammations. The appearance, mode of development, and effects of such mixed contagia are entirely different from those just described in the case of a typical hard chancre. In the former there is practically no incubation-period, signs of inflammation appearing within a few hours of infection. Soft chancres are quite commonly multiple; they secrete a copious and very infective discharge, and auto-inoculation may occur to any extent. In unhealthy individuals, and

when not carefully treated, the inflammation is often of a spreading and destructive kind ; the lymphatic vessels and glands are rapidly involved in the acute suppurative inflammation.

In such cases it is often only when the acute stage is past that the mixed nature of the contagion becomes manifest ; for the syphilitic virus, whether inoculated pure or in conjunction with other septic matters, after a certain period for its incubation, breeds remarkably true. This should always be borne in mind in forming an opinion in any given case. The alleged occurrence of constitutional syphilis after soft chancres is probably to be explained by such dual contagion, the more rapidly developing and acuter symptoms of the soft chancres diverting attention from the vastly more important, but less prominent, symptoms characterizing the earliest development of a hard chancre and the onset of true syphilis.

Scarring.—A true chancre is usually a source of very little trouble,

FIG. 405.—Chancroid of the penis, with contact-chancroid on the thigh, and a bubo at the apex of Scarpa's triangle (Porter).

the discharge being scanty and pain practically absent. Even when left to themselves, they tend to heal after three or four weeks; in healthy subjects, and when kept clean and protected from irritation, they often follow so mild a course that their significance is apt to be overlooked. Chancres leave no scar behind; when associated with much inflammation, which, as already said, is no essential part of the process, but rather a complication, scarring may result.

Secondary Incubation.—For a certain time, varying from three weeks to three months, during which they may quite disappear, the chancre and the associated hard glands represent the whole disease, a period which some authors describe as the "secondary incubation." It represents the time necessary for the multiplication of the poison and its dissemination through the body. Some persons remain the while quite unaffected in their general health; others begin to feel ill, especially

during the later part of this period; depression, malaise, elevation of temperature set in, and may increase to such an extent as to necessitate confinement to bed; aches and pains in the bones and joints, and head-ache, chiefly at night, are not infrequent among the symptoms of this secondary incubation-period. These symptoms vary both in detail and in severity, the personal element again being largely predominant. As a rule, the more rapid their onset the more severe is their type; that is to say, a short secondary incubation generally means a marked consti-tutional proclivity, and therefore a severer type of disease.

Diagnosis.—As regards the diagnosis of hard chancres, little diffi-culty will be experienced in a vast majority of cases. When sores occur on the genitals, our first suspicion is always of syphilis; and the history generally helps to decide the question. It is in dealing with chancres in *unusual* places, and without any trustworthy history, that difficulty and

FIG. 406.—Chancre of the upper lip (Porter).

doubt are chiefly experienced, and then only in the early stages. This, however, is the moment when a correct diagnosis is most imperative.

Until induration has occurred, even a practised eye may be deceived. A small, single, indolent sore occurring on the lip, or tongue, or eyelid, or finger, which, instead of healing, tends rather to increase, and which assumes an indurated character and is associated with indolent indura-tion of the nearest glands, can only be a hard chancre. No papule, or acne spot, or tubercle in the skin, or epithelioma, or wart, or local injury, or sting behaves in the same way. Given such a sore, the surgeon should carefully work up to a diagnosis by the method of exclusion. Occasionally it is inconvenient to admit the possibility of this disease, both on the part of the patient and of the surgeon; in such cases, and in all cases of doubt, a protective dressing and a mild course of mer-curial treatment should be recommended and commenced as a tem-porary expedient.

Prognosis.—The prognosis in cases of hard chancre should always be guarded. Secondary symptoms are almost certain to follow, and their severity does not appear to depend on the large or small size of the primary sore. The prognosis, however, may be very hopeful, for there is now no room to doubt that all the subsequent manifestations of the syphilitic virus, after the appearance of a true chancre, are modified, and to an extent controlled, by treatment begun early, efficiently carried out, and continued for a sufficient period.

Secondary Period.—The onset of constitutional infection is usually ushered in with a more or less marked rise of temperature. This is especially true in women. The pyrexia is not of long duration, rarely exceeds 103° F., and rapidly comes down as the eruption appears. In a few cases successive crops of eruption are associated with rises of temperature. On the other hand, many cases are either quite free from fever, or (what is more probable), the fever being slight, escapes observation.

Coincidently with this feverish condition there occur symptoms of malaise, loss of appetite, localized aches and pains, pallor, and a feeling of weakness. In not a few cases a general enlargement, with tenderness, of the superficial lymphatic glands may be discovered on examination at all places where glands usually exist. The late M. Ricord considered this adenitis the earliest, most constant, and characteristic sign of constitutional syphilis, and that its extent was a fairly reliable criterion of the degree of severity of the oncoming attack. Authors are not agreed whether this glandular enlargement precedes or accompanies the exanthem, or whether it is independent of it. In the neck, where the glands are usually quite easy to examine, they are generally secondary to affections of the throat and mouth, and appear to stand in direct relation to the severity of the mouth-affection.

General Infection.—Skin-affections.—Among the earliest objective signs that the disease has generalized itself and has become constitutional is the appearance of certain highly characteristic eruptions on the skin and mucous membranes. So constant are these eruptions that their presence is regarded as almost essential to establish the diagnosis. In some patients the eruption is very copious and very persistent, with intermissions; in others, slight and fleeting. It seems not improbable that the extent and intensity depend on the personal peculiarity of the patient rather than on the virus; for almost any rash to which the skin is liable in a general way may be found in association with syphilis. Syphilis, however, does impress upon these eruptions characters which, taken together, stamp them as specific.

In contrast with the skin-diseases of a later period, the secondary eruptions are remarkably symmetrical; according to Hutchinson, they affect the flexor in preference to the extensor aspects of the limbs. As regards color, it may be said. that they are of a dull-red, coppery, or lean-of-ham tint, due to the presence of pigment from disturbance of the *rete Malpighii*. Various eruptions and varying stages are commonly present in the same subject at the same time. As a rule, there is no itching or other irritation, and patients are often quite unaware of the presence of the eruption.

Roseola.—The commonest of the early rashes is roseola. It occurs

most markedly on the trunk and limbs, perhaps because they are covered; but may occur also on exposed parts. The rash may be very abundant or sparsely scattered about; very evanescent, and so even escape notice, or more chronic in its duration, and be followed by a slight desquamation and pigmentation. The eruption occurs as small dusky, rose-colored, discrete patches, varying in size from a millet-seed to a bean; not appreciable to the touch, disappearing momentarily when pressed, and generally circular or ovoid in form. The presence of such a roseola is highly characteristic, not merely of syphilis, but of quite recent syphilis; and most frequently, on careful search, other signs, such as the remains of a chancre, induration, or hard bubo, will be found.

Papules.—Perhaps the next commonest is the papular syphilide. This occurs as a crop of slightly raised papules, round or ovoid in shape, as large as lentils or beans even, brownish in color, with a smooth, glazed surface. The papules develop gradually, attaining their full size within about a week; they are neither painful nor irritable, and may be found scattered over the body generally, or grouped in some of the regions more especially selected by syphilitic eruptions. Sometimes they remain unchanged in their fully developed condition for several weeks or even longer, and then gradually begin to clear up; the course depending somewhat on the size of the papule and the amount of the exudation present. Even after reabsorption of the exudation there will persist for some time patches of somewhat pigmented and atrophied skin, which are very characteristic of syphilis. Not infrequently this and the roseola just described may be found side by side in the same patient.

Modified Papules.—This papular syphilide appears also in places and under conditions which greatly modify its appearance. Thus, in the palms of the hands and on the soles of the feet it becomes known as palmar or plantar psoriasis. The differences in character depend on the individual hand or foot; the more or less thickened epidermis being chiefly responsible. In some cases, where the papules are very numerous and the skin hard and brittle, painful fissures will occur and the epidermis will peel off in flakes. This eruption is often very chronic and liable to relapses. As ordinary psoriasis never occurs in these situations, the affection of the palms and of the soles is highly characteristic of syphilis.

Mucous Membranes.—On the mucous membrane of the mouth and fauces the papules take the form of raised "mucous patches" (plaques muqueuses). The tonsils, on account of their peculiar structure, are especially prone to a form of ulceration which is almost characteristic of syphilis. The ulcers are symmetrical, generally superficial, and kidney-shaped. In persons whose tonsils are naturally large and fleshy, these sores may be extensive; while in those with small harder tonsils, there may be little more than congestion, or merely a thin white film— "snail-track"—on their surface, similar to that found on the mucous surface of the cheeks and lips. The mucous membrane of the soft palate, uvula, and pillars of the fauces is usually inflamed and edematous; in persons in bad health this inflammation may assume a sloughy character and be associated with constitutional disturbance. In hard smokers and drinkers the mouth, lips, and tongue sometimes suffer severely.

Condylomata.—Further, in moist situations on the skin-surface, the

papules take the form of raised "white patches"; they are most commonly found where two surfaces are in contact, moist, and subject to a good deal of irritation, as about the genitals and around the anus, where they are often described as condylomata. Their extent, size, and duration appear to depend on the amount of direct irritation to which they are subjected. They are more common in women than in men, which is to be explained by the greater irritation to which these parts are subject in women. Their development is greatly favored by inattention to cleanliness; they readily ulcerate, and then give rise to a mucopurulent discharge of a highly infective nature, and they spread from the mucous orifices where they originate to the soft and moist skin adjoining.

FIG. 407.—Late serpiginous ulcerating syphilide (White).

These condylomata are well defined, usually circular or ovoid in shape; their surface is slightly raised, and on close examination will be found to be finely papillated. Histologically, they result from hyperplasia of the papillæ of the true skin, with inflammatory changes in the adjacent parts. It is from these condylomata, when neglected and chronic, that "venereal warts" arise in the later stages of syphilis.

Rupia; Lupus.—The foregoing are among the commonest forms of skin-affection, and are met with in almost every case of syphilis during the early secondary period. Other forms undoubtedly occur, and especially in debilitated and cachectic subjects. Whether they are to be considered properly syphilitic is somewhat doubtful. Thus, we may meet with vesicular and pustular eruptions, the latter apparently a later stage of the former; as the scabs fall off, patches of unhealthy superficial ulcer-

ation are left behind. Lichen and acne occur quite commonly among the syphilitic, and are distinguished from the ordinary forms only by a greater tendency to ulcerate, by their occurrence in positions not usually affected, and by the concurrence of other undoubted signs of syphilis. Rupia sometimes occurs among the early secondaries, though it is rare, and has usually been considered a tertiary manifestation. It begins as a bulla, the contents of which dry into a scab; as the base of the sore gradually enlarges by ulceration, so the size of the successive scabs enlarges, and thus a thick-pointed scab, roughly resembling a coarse oyster- or a limpet-shell, is formed. This eruption is very chronic and obstinate; general remedies are quite as necessary as specific ones. A serpiginous disease like lupus is occasionally met with at this period. It results from the breaking down of small, closely lying, gummatous nodules in the skin; or they may be tubercular in origin, which become modified by the syphilitic poison; they run their course very slowly, recur and relapse, and more properly belong to the tertiary period.

Hair.—As an appendage of the skin, the hair partakes in the general disturbance; it usually begins to fall out during the early secondary period, especially when it is brushed. In some few cases complete baldness may come on. More commonly, however, matters do not go quite so far. The hair loses its gloss and becomes dry; the scalp is often not appreciably altered on the surface. The falling out is due to some temporary trophic disturbance of the hair-papillæ. In young subjects the hair is rapidly reproduced; while in elderly persons, in whom the hair is naturally thinning and becoming gray, baldness may be almost complete and permanent.

Eye.—*Iritis.*—Another very important lesion at this stage of syphilis is iritis. According to the severity of the attack, the patient will complain of impairment of sight, discomfort in the eye, and of brow-ache, and sometimes of acute pain in the eye. On examination, sluggishness, with more or less contraction of pupil and change in color of the iris, will be seen, together with a well-marked zone of ciliary redness. There is not much photophobia in the syphilitic variety of iritis. In some cases nodules of lymph occur at the pupillary margin, and when present are highly characteristic. They are suggestive of an extensive inflammation of the stroma of the iris, and, unless actively treated, permanent damage to the eye or sight may result. Iritis occurs from three to six months after the chancre, and is sometimes the first among the secondary symptoms: more usually it occurs while the exanthem stage is at its height. Occasionally, iritis has attracted a more careful attention to other slight and unsuspected symptoms, and has led up to the correct diagnosis and treatment. In all cases the instillation of a solution of atropin is indicated, in order to dilate the pupil and thus prevent adhesions, which might possibly occlude it permanently. Iritis is very apt to relapse. Choroiditis also occurs; but is of relatively small importance. Retinitis occasionally develops, and fortunately quickly attracts attention by the dimness of vision with which it is associated. It may occur in one eye or in both. Vision may even be lost. The ophthalmoscope should always be used, and the extent of the mischief ascertained. Needless to say, treatment must be begun

early and continued long; the patient should be confined to a darkened room and carefully supervised.

By the time the foregoing symptoms have been experienced and have disappeared, an average period of eighteen to twenty-four months will have elapsed since the primary infection first occurred. Whether there will be recrudescences or recurrences of any of the symptoms, or, in other words, whether the patient has been cured of his disease or not, will depend upon the treatment which has been adopted, the time when treatment was commenced, and upon the personal susceptibility and idiosyncrasies of the patient; upon the absence or presence of other diseases, such as tubercle, rheumatism, malaria; and upon the attention given to the general health. If treatment has been thorough, a long interval of good health may follow. In not a few cases no subsequent reminders will be experienced at all.

Tertiary Period.—It must be freely admitted that there is no very precise line of demarcation between the secondary and the tertiary periods. The lesions are certainly less generalized over the body; that is to say, they are less copious and therefore less symmetrical than are the secondaries. And whereas the secondary lesions have chiefly affected the tissues derived from the external embryonic layer—the skin and its appendages—the tertiary lesions seem to attack by preference the derivatives from the middle layer, viz., the connective-tissue series—bone, periosteum, muscles, nerves, arteries, and the viscera. A doctrine formerly held by a few prominent teachers, that secondary symptoms yield to mercury, while potassium iodid is the remedy for tertiary lesions, has not been substantiated by longer clinical experience. The most important clinical difference is the diminishing infectivity of the lesions of the tertiary period. As is well known, the secondary lesions are highly contagious as well as transmissible. In the tertiary, and especially in the advanced tertiary, period, there is neither infectivity nor transmissibility; but it is exceedingly difficult to know exactly when this latter stage is reached.

The essential feature of the syphilitic lesion of the tertiary period is a low form of new growth—the so-called **gumma.** This may occur either as a diffuse infiltration or as discrete nodules, and may affect any of the tissues as well as the internal organs. Gummata may be of any size, from that of a pin's head and upward, single or multiple. They resemble some forms of tumor-growth; but, unlike the simple tumors, they cannot be shelled out, and, unlike the malignant tumors, they are purely local and do not infect the body at large. Histologically, this new growth is embryonic in character, and apparently incapable of higher organization; like all other syphilitic products, it is essentially short-lived, liable to degenerate, and thus to retrogress. A typical gumma, whatever its size, almost always shows traces of degeneration in its center, due to its want of vascularity. After attaining a certain size, and especially when superficial, they break down in the center and slough out; in other cases they ulcerate slowly, undermining the neighboring tissue.

Bones and Joints.—It has long been known that the bones and periosteum suffer severely in syphilis; and reference has already been made to fleeting aches and pains which not infrequently accompany the earlier

manifestation of the secondary period. During the tertiary period, however, these pains and bone-affections are more lasting and more intense. The pain is especially severe at night, and very apt to occur near the attachment of large muscles. At first there is no change appreciable, either to the eye or the hand; but later on either local or general swelling, sometimes with great tenderness, becomes apparent. This is chiefly the case where the bones are superficial, as on the shins and on the skull. Generally, after some preliminary discomfort, a swelling, more or less ovoid in shape, gradually appears and increases in size and extent; its growth may be chiefly central, toward the medullary cavity of the bone (the tibia, for instance), or more toward the surface; it may be quite unconnected with the periosteum. When localized, such swell-

Fig. 408.—Tertiary lesions healed by large doses of potassium iodid (Porter).

ings are called nodes; when a bone is more extensively affected, it may be better described as a hyperostosis. The nodes may remain hard, or gradually soften, inflame, and slough out like a gumma in any other situation. The process is one of slow chronic inflammation; and the pain is due to the unyielding nature of the tissue affected. The course taken depends very much on the individual case and on the treatment, previous as well as actual, adopted. Injuries not infrequently seem to determine the occurrence of these nodes. The whole of a long bone may be affected and become hypertrophic; or nodes may appear locally, when the bone will assume a bossy appearance. When single, these nodes very usually occupy the middle of the shaft, in this respect contrasting with tuberculosis as well as malignant disease, the favorite seat of which is near the expanded extremity adjoining the epiphysis.

Periosteum.—The bone disease is sometimes most marked near the surface and associated with periostitis. Periosteal nodes are very common, and are brought about much in the same way as the nodes—by chronic inflammation of a somewhat low type. They may be very painful, owing to the unyielding nature of the tissue. In some cases the process may be very slow and chronic; and, instead of ulceration, an ivory-like thickening of the bone takes place, which remains permanently, or only disappears after years. Certain bones seem specially prone to the disease; thus the tibiæ, the clavicles, the ribs, and the bones of the skull suffer with great relative frequency. The palate and nasal bones are also very prone to the disease, which often assumes a semi-gangrenous and offensive character, and leads to more or less local deformity, the nose, mouth, and pharynx being opened into one cavity. Ozena is quite frequently the result of syphilitic disease of the nasal bone, in conjunction with the adjacent mucous membrane. It is doubtful whether this is a primary bone disease; more probably it starts in

FIG. 409.—Gumma of the frontal bone (C. A. Porter's case).

the mucous membrane and then attacks the bone. In a few cases the base of the skull becomes involved in the disease, which may spread through the dura mater to the brain and the nerve-trunks arising therefrom, with the most varied and often disastrous results. The bones of the cranium, especially the frontal and the parietal, are apt to ulcerate; first, there is a gummatous infiltration, either in the bone itself or in the pericranium, which gradually breaks down and involves all the structures, leading to ugly undermined ulceration in the soft parts, with exfoliation of areas of the bone, and, if recovery occurs, to extensive scarring.

The pathological appearances of a tibia, for example, affected with this disease will vary with the period at which the bone is examined. If early the bone may only appear more vascular than usual; at a later period the medullary cavity may be more or less filled with new growth; or the entire shaft may be enlarged, uniformly or otherwise, and heavier than normal; or localized areas may be infiltrated with gummatous material.

Joints.—The fibrous structures around joints are not infrequently

affected, nodes making their appearance; the joint-cavities also suffer primarily, a sort of spurious rheumatism sometimes supervening; in some cases disease in the bones themselves spreads to the joints more or less acutely. In other cases there is a more chronic and relapsing synovitis, which may give rise to a great deal of trouble. Subjects with the rheumatic diathesis seem specially prone to these joint-affections in the course of their syphilis.

Muscles.—Gummata occur also in the muscles, sometimes very large ones; and, according to their seat, give rise to considerable inconvenience.

Tongue.—Owing, doubtless, to the many sources of irritation to which the tongue is subjected, gummata occur with considerable frequency in its substance; they appear at first as round or elongated, hardened masses in the substance of the organ, gradually growing toward the surface. They are often painless. On the other hand, they not infrequently ulcerate, become very intractable, and simulate epithelioma. Syphilis, however, is less painful than epithelioma, and there is less implication of the lymphatic glands. The lingual mucous membrane sometimes hypertrophies and becomes fissured and tender, either in patches or over its whole extent. This condition is analogous to the warts found in other places. Tongue disease is most frequent and seen in its worst form among those who are excessive tobacco-smokers.

Nervous System.—There are many reasons why tertiary syphilis of the nervous system should demand special attention, for not only may it suffer directly, but it may also be implicated secondarily, and in either case grave consequences result. If the central nervous substance is attacked directly, there is danger of this highly specialized tissue being completely destroyed, or the fibrous stroma in which the proper nerve-elements are embedded may be affected and seriously jeopardize their function; or a nerve-trunk may be pressed upon as it passes through a bony foramen or along some bony groove. Again, the nutrition of the nerve-substance may be altered in consequence of changes in the arterial system. The clinical results of such various lesions will obviously depend on circumstances; there may be abolition of function, complete or only partial; and this again may be either permanent or temporary. For instance, should the retina become affected, blindness may result; should the spinal cord be attacked, locomotor ataxia will ensue. Affections of other parts will have, each according to its function, a corresponding sequel; and in proportion to the specialization of the nerve affected, so will be the gravity of the lesion and of the prognosis to be given.

Viscera.—Gummata may affect any of the viscera. Of chief importance are affections of the liver and of the testis, as much by reason of their frequency as of the importance of these organs. They occur in the lungs; in the heart-muscle; probably also in the stomach, where they may be a cause of ulceration, and in the rectum, being not infrequently a cause of stricture. The reader is referred to the chapters dealing with these special organs for a more detailed account.

Syphilis of the **upper air-passages** presents nothing special. It may, however, sometimes prove dangerous to life, because of the importance of the respiratory function rather than because of its extent

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or severity. Either the mucous membrane or the cartilaginous framework of the larynx, or both, may be the parts first affected; and owing to swelling or to edema acute and dangerous symptoms may set in, and with sudden and startling rapidity. In more chronic cases, after softening and sloughing out of the gummata, cicatricial narrowing occurs.

In a brief essay of this kind, it is difficult to do more than sketch the possibilities of this disease, so uncertain and yet so universal in their probable incidence. With a history of past syphilis, obscure symptoms in viscera, nervous system, or elsewhere, occurring without other obvious cause, may not unfairly be suspected to be due to syphilis, and cautiously treated by the appropriate remedies.

Hereditary (or Congenital) Syphilis.—The offspring of parents actively syphilitic often suffer from disease of a well-marked type and having very definite features—so-called hereditary syphilis. This is hardly the place to discuss in detail the relative share taken by father and by mother in the production of syphilitic children. Speaking generally, it may be said that a diseased father or a diseased mother suffices to endanger the fetus; when both parents are infective, the danger to the fetus is still greater. The activity of the parents' disease at the time of procreation—which appears to be in direct ratio to the date of its acquisition—is a contributory element of the first importance in insuring both transmission and intensity. The varying degrees of severity in the hereditary disease met with in practice are probably thus explained. A few children are born with the disease fully out on them; in the majority of cases the disease only becomes manifest some weeks after birth; in a small percentage the earliest manifestations may be delayed for years. The following descriptions must be taken as collective rather than as individual. It is most unusual for all the enumerated symptoms to occur in each case; indeed, the greatest latitude must be allowed.

How the disease is conveyed from the sperm to the ovum is not known. Why a certain number of children suffer from the disease, though their parents show no signs of syphilis; why a certain number of children of obviously syphilitic parents appear to escape the disease altogether; why, in the case of twins, occasionally one escapes scot free, while the other suffers severely, are among the problems which as yet remain quite unexplained.

This much we know, however, that the syphilitic poison is highly detrimental to the ovum in a large proportion of cases, destroying it before it has had time to germinate—in this way preventing conception —or at a later period blighting the fetus, so as to lead to miscarriage or premature birth. When the poison is more attenuated, the fetus may survive to term and be born alive, with or without external signs of its tainted origin.

General Symptoms.—*Severe Cases.*—The infant, even when not prematurely born, is usually small and atrophic; its skin is often thick, coarse, and wrinkled. When syphilis is manifest at the time of birth, or becomes so very shortly afterward, it is always of a severe type and generally fatal. A common symptom in such cases is pemphigus, a bullous eruption, which, while occurring over any part of the body,

has special predilection for the palms of the hands and soles of the feet. The bullæ vary in size from that of a pea to an egg, occur in successive crops, the fluid contents of which rapidly become purulent. Sometimes the whole body appears as if it had been superficially scalded, and large flakes of loosened epidermis can be peeled off. The anus is often fissured and ulcerated. The scrotum and penis are swollen, red, and excoriated.

The *mucous membranes* usually suffer considerably. A diffuse stomatitis, with "white patches" on the inner surface of the cheeks and lips; small ulcers on the tongue; inflamed gums with, occasionally, suppuration of the dental sacs, may be present; radiating fissures at the angles of the mouth, with excoriation of the adjoining parts, are found, as a rule. The cry is feeble and hoarse, from participation of laryngeal mucous membrane in the morbid process. The nasopharynx is in a similar condition, and yields a copious mucopurulent discharge. The interference with nasal breathing is often considerable, to which the term "snuffles" is specifically applied; besides being a source of great discomfort, it seriously interferes with sucking, and so adds indirectly to the child's danger.

Multiple Arthritis.—Another not infrequent occurrence in these severe forms is multiple arthritis. The affection usually comes on acutely, attacks more than one joint, often several in rapid succession, and leads to loss of power—pseudoparalysis so-called. The infant attracts attention by its constant moaning cry, especially while being handled or dressed; sometimes the absence of movement first attracts the mother's attention. On examination the affected joints will be found swollen, excessively tender, sometimes disorganized, and the limbs below quite powerless.

Symptoms in Milder Cases.—The syphilitic infant, however, is usually born without any signs of disease, and may remain apparently healthy for three or four or more weeks; it may even be fat and well nourished. Then gradually it begins to fail, and loses its plumpness and healthy color. Nasal catarrh—"snuffles"—begins; and this is quickly followed by a coppery roseola, sometimes by a papular eruption, with or without scales, and of a *cafe-au-lait* tint. Usually, sores will commence about the anus; sometimes well-marked "white patches" will be found there. These symptoms vary very much in their intensity. The rash may cover the whole body or concentrate itself about the mucous orifices. In the milder forms of this disease, it is not common to find much affection of the mucous membrane of the mouth; but the mouth, pharynx, and even the larynx may be affected; and besides some alteration in the voice, swelling may occasionally give rise to difficulty in the respiration. The lymphatic glands in the neck may enlarge.

The symptoms in some cases are most scanty, merely snuffles and a few spots; or a broad, flattened condyloma about the anus; or just a little hoarseness—symptoms which, without a clear history of syphilis in the parents, would hardly suffice for a diagnosis.

The *skin-eruptions* are largely influenced and located by external irritation; hence their frequency around the lips and in the neighborhood of the anus and scrotum. Indeed, external irritations often determine the date of outbreak of the skin-eruptions. The change from the

intra-uterine to extra-uterine surroundings must be a shock to any child; and when these latter are specially unfavorable, the surface-lesions of inherited syphilis are proportionately aggravated. It must never be forgotten that many infants quite free from syphilis suffer from " sore bottoms " produced by the irritation of unhealthy feces and of urine and by want of attention; consequently, before a diagnosis of syphilis can be given, other more specific signs must be present. Moreover, the aspect of the lesions is easily influenced by treatment; and should mercury have already been given, either accidentally or by design, before the child comes under notice, the surgeon may easily arrive at a wrong conclusion as to the nature of the case.

Bones.—Next, both in frequency and in importance, to affections of the skin come those of the bones. As the skin is rarely attacked in its whole extent at one and the same time, so it is with the skeleton; as on the skin, so among the bones there are seats of election. Some bones show a proneness to suffer more severely than others; these are the bones of the skull-cap, the scapula, the ilium, and the long bones of the extremities, though all other parts of the skeleton may suffer in very severe cases. Clinically, the chief character of the affection is a peculiar thickening of the bone, more or less in layers or bosses, which is found to depend on an irregular osteophytic deposit on its surface. In marked cases this condition can be seen as well as felt. The deposit occurs chiefly along the sutural margins of the skull-cap, where it can be traced with the finger as a rounded, elevated border; it is especially observable at the four corners of the anterior fontanel, extending backward and forward along the line of the sutures, to which the term "natiform" swelling has been applied. This condition of the bones, which is inflammatory, appears to lead in some cases to premature closing of the sutures, and so may even arrest the growth of the brain in very marked cases. The parietal bone is attacked most frequently, then the frontal, and lastly the upper part of the occipital. The parietal and frontal eminences are not attacked until the whole bone is more or less affected. The other flat bones—scapula and ilium—are much thickened, especially along their free margins. A similar deposit is found also on the long bones of the extremities. In these the osteophytic deposit, in extreme cases, entirely encases the bones, producing during life a thickened condition, with tenderness on pressure, by means of which the disease may be recognized. The deposit is always thicker at the extremities of the diaphysis; but the epiphysis, notwithstanding, may be quite normal. The condition is distinct from the multiple arthritis alluded to in a preceding paragraph; it affects, as a rule, rather older children, and is associated with a less severe type of disease. The deposit occurs in superimposed layers, as though there were intervals of activity and of rest, comparable with the tendency to relapse not seldom seen in other syphilitic lesions, or perhaps with the too early suspension of treatment. The accompanying illustration (Fig. 410) gives a very correct idea of this form of the disease. It is one of the lesions most amenable to mercurial treatment, under which it rapidly disappears.

A less common form of bone disease in infants at this period is shown in Fig. 410, 3. Here, instead of a sheath of new bone, we have

local thickenings similar to those found at a later period of life, to which reference will presently be made.

All these lesions are easily intensified by rough handling; the mere act of dressing and undressing, muscular movements, and the like tend to aggravate even the slighter cases, and to introduce factors and conditions apart from syphilis. When such conditions are suspected or detected, the limbs should be swathed in soft dressings and carefully immobilized. The flat bones—scapula and ilium—are usually found much thickened along their margins.

Pathologically, the change is in the bone itself, and not in the periosteum, for the latter will peel off without any difficulty—indeed, more
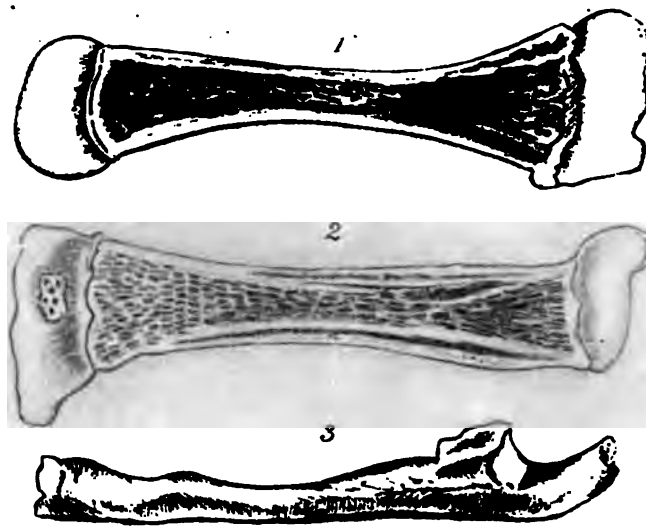
FIG. 410.—Bone disease in infants (hereditary syphilis). 1. Left humerus: shows the sheath of new bone which surrounds the lower half of the shaft. There is nothing abnormal along the junction of the shaft with the epiphysis. 2. Right tibia: the whole of the diaphysis is enclosed, as it were, in a sheath of new bone. Epiphyseal junction normal. 3. Left ulna: shows the nodulated condition of the surface of the bone. There was no sheath of new growth, as in the other bones, along the whole of the shaft, but rather a local thickening in two or three different places. (From a male infant, who died in the East London Children's Hospital, aged nine weeks.)

easily than usual. The exact appearance of this osteophytic infiltration will depend on the age of the patient and of the disease; whether the case has been treated with mercury or otherwise; and, finally, on whether the bones are examined immediately after death or after maceration and drying. Seen shortly after death, these bones are dark red or purple in color, from the vascular congestion. Two or more layers of new growth may be found superimposed, the outer layers being generally softer than the deeper ones. The deposit consists of a coarse, open, trabecular framework of new bone, filled with an inflammatory infiltration of newly formed embryonic tissue. The bones at this stage can be easily cut with a knife. In the cases in which treatment arrests the further course of the disease, these changes slowly retrogress, and

in course of time may disappear entirely; in others, either of a more severe type or untreated, later changes of an ulcerative type set in, and more or less caries, with its results, will be observed. The skull-cap (either within or without) will show traces of erosion, and may even be perforated.

Viscera.—In a considerable number of cases the spleen will be found enlarged, sometimes considerably. The liver, too, is occasionally enlarged at the same time. Apart from mere enlargement now referred to, and which under favorable circumstances will slowly subside, in some few cases syphilitic new growth may be found in both these viscera after death. As exceptional occurrences, these organs, one or both, may be found infiltrated throughout with new growth, either in patches or uniformly, as though the growth had commenced early during intra-uterine life and run *pari passu* with the development of the organ. Severe visceral lesions of this kind are not always associated with the most marked surface-lesions, perhaps because the syphilitic poison has concentrated and exhausted itself in producing the condition.

Iritis.—According to Hutchinson, iritis occurs occasionally in syphilitic infants; and, on account of the slight symptoms which attend it in many instances, it is liable to be overlooked. One eye or both eyes may be affected, either together or in succession. The average age is five months, and the condition is mostly associated with other symptoms. The disease is most common among the offspring of parents who have themselves but recently acquired syphilis. It may be recognized by alteration in the color of the iris, by irregularity of the pupil, and by the presence of more or less lymph. A guarded prognosis should be given. The treatment must be cautiously pushed; and atropin instilled, in order to keep the pupil as widely dilated as possible.

The *testis* is another of the viscera for which hereditary syphilis has a marked predilection; the disease occurs in infants of three months and upward. Very occasionally a diseased testis has been found in a full-term fetus. On examination the affected testis is harder and larger than a normal one, uneven on the surface, and sometimes associated with hydrocele. On section the organ is found infiltrated with gummatous deposit.

Other lesions occur, though less frequently; some are demonstrable only after death. Indeed, it seems as if any part of the body may be affected. In *post-mortem* examination of young children the subjects of this disease, extensive affection of the arterial system (Heubner's changes), gummata of the dura mater, of the cranial nerves, of the heart, lungs, kidneys, and extensive choroidal disease have been found.

When the early period of the disease has been safely passed, many syphilitic children grow up very much like other children, some may even show no further signs of their diathesis; others may be anemic and weakly for a time. Others, again, acquire a peculiar and unmistakable physiognomy; the nasopharyngeal affections, according to their severity, lead to the destruction of the vomer, palate bones, or ethmoid, as well as of the soft parts; or to alterations in conformation and atrophy; and, as a result, the face and nose acquire the characteristic appearance referred to. The vault of the cranium and the forehead sometimes become permanently thickened, becoming square-shaped.

Apart from this, however, the health is good, and development takes a normal course. Much depends on a careful and well-sustained course of treatment during the earliest stages.

The Contagiousness of Inherited Syphilis.—A question which the surgeon will often be called upon to decide is, " How shall a syphilitic infant be brought up?" The disease is so frequently latent and unsuspected at birth that the mother may already have begun to suckle it or have procured a wet-nurse; and it is only some days or weeks later that the truth becomes apparent. What is to be done under the circumstances? First, in those cases in which the mother is nursing her own infant, the mother may continue suckling, with the fullest confidence that she will not acquire syphilitic disease from her own infant, even if its mouth is affected. These infants can ill afford to be deprived of breast-milk; and on no account should they be weaned as long as the mother is able and willing to suckle them. It is quite otherwise with regard to the wet-nurse; and should an infant who is being suckled by a stranger nurse develop syphilis, the surgeon will naturally at once inform both the parents and the nurse, and point out the possible risks of infection. In all probability, even should the surgeon sanction it, the wet-nurse will decide not to incur further risk: it will be necessary, however, to keep her under close observation for some weeks, until it is quite certain that she has not already been infected.

It was about the year 1837 that Abraham Colles, the celebrated Dublin surgeon, as the outcome of a very large experience, first enunciated the doctrine that a congenitally syphilitic infant never infects its own mother with syphilis, although a healthy wet-nurse rarely escapes the infection. He wrote: " I have never seen or heard of a single instance in which a syphilitic infant (although its mouth be ulcerated), suckled by its own mother, had produced ulceration of her breasts; whereas very few instances have occurred where a syphilitic infant has not infected a strange hired wet-nurse who had been previously in good health."

This doctrine is now called "Colles's law," and is very generally accepted; by the majority, it is regarded as absolute; by a small minority, on the other hand, exceptions to the rule are allowed to occur; but these exceptions are very few and far between, and practically may be disregarded in connection with the question of suckling by the mother, though she herself is apparently free from disease.

There is no recent clinical evidence which quite realizes Colles's teachings, viz., that a healthy wet-nurse who suckles a syphilitic infant becomes infected, while the infant's own mother, who has also suckled this same child, and has been brought into closest contact with it, escapes. It is not very remarkable that a mother should not be infected with disease from suckling and handling her own infant, which is really part of herself. It is only when this same infant infects every other healthy person with whom it comes in contact that the mother's invariable escape becomes so striking. The importance of taking Colles's teaching as a whole cannot, therefore, be overrated. For, obviously, some one must be infected by the infant, in order to demonstrate beyond doubt that its disease is contagious. In the instances in which a wet-nurse alone suckles a diseased nursling and succumbs to infection, we

lack the demonstration, in the given case, that the mother, too, would not have been infected had she nursed this obviously contagious infant to an equal extent. Colles relates instances of wet-nurses and their families becoming infected from infants suffering from inherited syphilis, which he regarded as one of the most contagious of all diseases. It was the extreme contagiousness of these syphilitic infants that led him to make the observations on which " Colles's law " now rests.

The contagiousness of what is now called inherited syphilis, however, is being more and more questioned by present-day workers. At the children's hospitals in London, where vast numbers of children with this inherited disease are annually seen as outpatients, few, if any, cases of chancre-syphilis infected from the inherited cases are met with, although the children mostly come from very poor and overcrowded homes, where there is little to prevent, and much to favor, the spread of any contagious disease that may be present. In the East London Hospital for Children, where there is a special ward for young infants, in which a great number of the severest cases have been nursed during the past twenty years, no single case of accidental infection has been recorded.

The questions thus arise: Has inherited syphilis changed in character since Colles's day? Do we apply the term more widely now than was formerly done? and, Are we less exacting in our requirements as to the syphilitic antecedents of an individual than was Colles? It seems not improbable that all these factors are at work. The more extended knowledge of syphilis; its earlier, better, and more systematic treatment, thanks to advancing medical knowledge and to the facilities afforded by public hospitals and dispensaries all over the country, are together gradually exercising a controlling influence—in the Darwinian sense—on the disease. Thus, it is highly probable that very much of what is now called " inherited," or " congenital," syphilis is not strictly syphilis, in that it is not contagious; but rather a new type of malnutrition, of constitutional deterioration in children, brought about by the toxins of syphilis acting on the parents.

In a few cases syphilis has been propagated by nurslings supposed to be suffering from inherited syphilis. Colles records one such case, which at first he took to be an exception to his doctrine of non-infectivity; but on further consideration he concluded that the infant in question had acquired ordinary syphilis after birth, from some woman other than its mother, who might have nursed or handled it. In every case of asserted infection by a congenitally syphilitic infant this possible fallacy must be looked into. It is quite easy for a newborn infant to acquire syphilis either at its birth from its mother or after birth from some other source of contagion; for every child whose parents are so actively syphilitic that they beget infected children is born into a contagious environment, and may readily succumb. The writer thinks that when syphilitic infants prove contagious, their disease has been acquired at birth or immediately after.

Boerhaave, in his *Aphorisms*, published nearly two hundred years ago, recognized both the acquired and the congenital forms of syphilis; but warned his readers that much of the infantile variety might be conveyed to the child by infected nurses. The surgeon should therefore be on his guard, first and foremost, not to mistake acquired syph-

ilis for the hereditary form; and, secondly, not to overlook so contagious a malady as this when it occurs.

That chancre-syphilis has been produced by infection from the congenital form is hardly to be doubted; but the cases are extremely rare. If further experience demonstrates that much of what we now call hereditary or congenital syphilis is not contagious, "Colles's law" will lose something of its present significance; though Colles's teaching will still have a very important bearing on practice. It will lead, probably, to a more precise nomenclature, and to a more careful study of the disease and the conditions of its production; and, in time, to a recognition of what is really syphilis, and therefore contagious; and what is possibly the *result* of syphilis, and therefore non-contagious. It is needless to say that the medicolegal aspect of the question is one of great and growing importance.

It is very interesting to note that the subjects of this inherited disease cannot transmit the disease to their descendants, and they themselves, when adequately exposed to the contagion of ordinary chancresyphilis, become infected and manifest the usual train of symptoms.

Vaccinosyphilis.—The contagiousness or the non-contagiousness of inherited syphilis is of great social interest, on account of vaccination hitherto practised from child to child. Unfortunately, syphilis has occasionally been propagated by this operation. Considering, however, the millions of vaccinations that have taken place, the almost endless number of infants suffering from this so-called "hereditary syphilis," and, notwithstanding, the very small number of recorded cases of infection, it must be conceded that the risk of infection is small indeed. These facts, on the other hand, may not unfairly be used as an argument against the specific contagiousness of the congenital form of syphilis. Were this inherited disease as contagious as Colles held it to be, the number of accidents by this time would have been enormous. This aspect of the question loses some of its interest now that human lymph has been discarded in favor of glycerinated calf-lymph for protective vaccination against small-pox. In this connection it is hardly necessary to impress on the young surgeon the need of the greatest care in vaccinating children, whether they be syphilitics or otherwise; and to avoid the use of vaccine lymph from all but the most healthy infants should calf-lymph not be obtainable.

Late Syphilis.—Syphilis sometimes manifests itself at a much later age, either in cases that have never been previously affected or but very slightly affected. In proportion as these symptoms occur late, the lesions are chronic and but little amenable to treatment. Whether we are justified in regarding such cases as syphilitic at all is open to doubt. That the lesions occur in children who have had earlier signs generally held to be syphilitic is quite true; but they occur with nearly equal frequency in cases in which neither a family nor a personal history of syphilis can be obtained.

Chronic Interstitial Keratitis.—This is one of the earliest of the later symptoms of inherited syphilis. Hutchinson, who was the first to demonstrate this connection, states that interstitial keratitis occurs between the ages of five and eighteen years; that it almost invariably affects first one eye and then the other; and that it usually commences

as a diffuse haziness near the center of the cornea. When carefully examined, the haze consists of " dots " situated in the substance of the cornea. After a few weeks these " dots " enlarge and then coalesce, rendering the whole cornea densely opaque, like ground-glass. There is by this time some intolerance of light, with pain in the orbit; and the patient has only bare perception of light. Under favorable circumstances the disease may begin to recede and sight be ultimately restored. In more severe cases the cornea becomes salmon-colored from vascularity; and though great improvement may still take place under appropriate treatment, vision is often considerably damaged. The duration of this complication varies from eighteen months to two years, or longer.

The Permanent Teeth.—The permanent central incisor teeth are often affected, and in so characteristic a manner as to become almost pathognomonic of the disease. These teeth are usually short and narrow, with a broad vertical notch in their edges, and rounded corners. When present, such teeth are a valuable corroboration in doubtful cases; and

FIG. 411.—Hutchinson's teeth : 1. The central upper incisors of a lad, aged fifteen years, the subject of inherited syphilis. The teeth are short, convergent, narrow from side to side at their edges, and show in each a vertical notch. 2. These teeth present similar characters. The notches, however, are less deep, whilst the narrowing from side to side is very marked. 3. The upper incisors of a girl aged seventeen years. There is a wide space between the central ones, and both these teeth, although of nearly normal length, are narrow, and show deep vertical notches. As is usual, the lateral incisors are of normal size and form. These teeth are not so typical as those shown in 1 and 2.

when well marked they are conclusive of syphilis. Unfortunately, they are not available for diagnostic purposes until after the child is about eight years old. Their absence, however, cannot be held to exclude syphilis when other signs point in that direction. The writer has Hutchinson's special permission to reproduce the accompanying drawings of the " test teeth " first published in 1863, in his now classical work, entitled *Clinical Memoir on Certain Diseases of the Eye and Ear Consequent on Inherited Syphilis*, in which the reader will find these matters admirably discussed and described.

Bone-lesions of Late Period.—Some very peculiar affections of the bones occur during later childhood, from about ten years of age and onward. The affected bones increase until they may become almost twice their normal size : sometimes the whole diaphysis, sometimes only a part, is affected. In the latter case the thickenings usually occur in the middle third of the shafts. In other cases, instead of a general hypertrophy, there are localized ovoid swellings—osseous nodes. The earliest symp-

tom of this affection is deep-seated, persistent, aching pain, sometimes very severe in character. The changes occur very slowly, last a long time, and may even be permanent; though they yield, as a rule, to a long-continued treatment with mercury and potassium iodid, singly or combined. The accompanying illustration (Fig. 412) represents a typical case.

The patient, a girl, aged thirteen years, was the second of three children, and had hitherto enjoyed good health. For about three months before coming under observation she

FIG. 412.—Bone disease in hereditary syphilis; later lesions. Julia B, aged thirteen years: symmetrical hyperostoses on lower jaw, corresponding with the insertion of the masseter muscles. Left arm of the same patient, showing localized hyperostoses on the radius and ulna.

had suffered from severe and increasing pain in several bones: then the ovoid swellings gradually appeared over the angles and ramus of the lower jaw corresponding with the insertions of the masseter muscles. Finally, ovoid swellings on the middle third of the left clavicle, on the tibia, on the left humerus, radius, and ulna slowly appeared: they had existed about a year when the drawings were made. The teeth were quite normal: the general health at this time was excellent. Mercury and potassium iodid were ordered singly and combined, and under this treatment the pain subsided: the swelling on the clavicle also subsided, but the other clavicle became affected for a while and then got well. The swelling in the other bones, however, continued to increase, and growths appeared in some other of the long bones. In the next three or four years, during which she was under constant observation, she went through an attack of interstitial keratitis, first in one eye and then in the other. She became little by little absolutely deaf; the general health began to

suffer, became more and more affected, and the girl died of an obscure brain-lesion, not improbably due, as was the deafness, to pressure of hypertrophied bone on vital structures. This girl's sister was also seen at short intervals. At one time she appeared quite well : then interstitial keratitis came on, and ran its usual course. After this the girl was lost sight of.

Another and somewhat similar case is illustrated by Fig. 413. The patient, a boy, aged fourteen, with normal eyes, and white, well-formed teeth, is the oldest of seven children, and the only one affected. The history as to syphilis is quite negative. The boy's father was married at the age of seventeen ; his mother, at the age of nineteen. Neither parent shows any trace of syphilis. The patient himself remained normal up to his seventh year, though he was somewhat anemic. At this period he began to grow : the enlargement of the long bones began about the same time, and has slowly progressed. In

FIG. 413.—Extensive bone disease in hereditary syphilis.

1893 he came under the care of the writer's colleague, Zum Busch, at the German Hospital, and was ordered mercury and potassium iodid ; but as he attended very irregularly and for short periods only, the result of treatment was practically *nil*. Now (1899), the condition of the bones is well shown in Fig. 413. There are also well-marked suppurating gummata, the first beginnings of which only date back some five or six months. The bones have gradually increased to their present size.

Condylomata.—Another late symptom, and sometimes a solitary one, is the appearance of broad, raised condylomata about the anus and vulva and elsewhere on the skin, especially on parts which, from being in mutual contact, are usually moist. Even when alone, such a condition may be pronounced syphilitic, and should be treated accordingly.

Mercury should be given internally, in small doses in conjunction with strict cleanliness of the affected parts. After washing, the condylomata should be freely dusted with a powder consisting of zinc oxid, 3 parts; calomel, 1 part.

Malnutrition.—Malnutrition, evidenced by chronic pallor, anemia, debility, indefinite aches and pains, is occasionally the sign and result of a syphilitic taint. In such cases mere tonics do not suffice to effect a permanent cure: mercury in some form or other must be added.

Larynx.—The brunt of the disease sometimes falls on the larynx and air-passages. In early infancy the mucous membrane suffers in the manner already referred to; and in a few of these cases which have resisted treatment or relapsed, chronic thickening of the mucous membrane—even a warty condition of the larynx—may result, and become a source of trouble and danger. In other cases ulceration or sloughing results; and in later years dyspnea may supervene from slight causes (*e. g.*, catarrh), owing to cicatricial changes which follow healing.

A somewhat unusual case of this kind came under the writer's care, in the East London Children's Hospital, a few years ago; and he has seen others of a like kind, though not quite of the same extent or severity. The patient, a boy, aged fifteen years, having a well-marked syphilitic physiognomy, but with white, well-formed teeth in sound condition, was admitted with a tracheal fistula from wearing a tracheotomy-tube, interstitial keratitis

FIG. 414.   FIG. 415.

FIG. 414.—Endotracheitis and endobronchitis (natural size). FIG. 415.—Trachea at bifurcation. Horizontal section through the trachea, 0.8 cm. (0.3 inch) above the bifurcation. Cartilaginous rings are normal. The lumen is greatly reduced in size by the hypertrophied mucous membrane.

which appeared to be clearing up, and large nodes on each tibia, that on the right side softening, exceedingly tender, and threatened with suppuration, that on the left side less advanced. Besides marked stridor and dyspnea, there were evidences of chronic and extensive lung disease, from which he ultimately died. He was the third of 9 children, of whom 4 died in infancy; none of the survivors showed any signs of syphilis, neither did his father nor his mother. A satisfactory history of infantile syphilis could not be obtained. When about ten years of age he began to suffer from ulceration of the soft palate, which ultimately was partially destroyed, the remains becoming adherent to the posterior pharyngeal wall, so that a tube passed through either nostril could not be made to reach the mouth. Some cicatricial narrowing of the upper air-passages had also taken place, and during a catarrhal attack had necessitated tracheotomy, from which he recovered. During the next five years he remained under constant observation. The limbs were enveloped in bandages spread with mercurial ointment; and under this treatment, which was continued, with intermissions, for some months, the nodes and the pain and tenderness gradually and completely disappeared. Notwithstanding every care, change of air, general tonics, etc., the boy very slowly wasted and died with symptoms of chronic fibroid phthisis. The *post-mortem* examination revealed a condition of obliterative endotracheitis and endobronchitis, which are well shown in Figs. 414, 415. The lungs presented the anatomical appearances of extreme interstitial inflammation, with large tracts of dense fibrous tissue everywhere. Two gummata were found in the brain, just above the corpus callosum, the parieto-occipital fissure running between them. They contained thick, gummy, tenacious pus. The endotracheitis, in all respects corresponding to the obliterative endarteritis of Heubner, was the most striking feature of the case. These changes were confined to the interior of the trachea

and main bronchi. The drawings are life-size : they show that the lumen is reduced to one-third of its normal size. It is remarkable how little dyspnea was present until within a few days of death.

Prognosis of Syphilis.—Not merely because syphilis may attack subjects of any age, but because of its long and uncertain duration, must the prognosis of acquired syphilis be guarded, even in those cases in which it justifiably seems very hopeful. In some people the disease is most formidable ; in others, though very characteristic, mild and apparently fleeting. The younger the patient, generally speaking, the more serious the disease. In young, growing people, who have still their framework to build up, the disease may prove a very serious matter indeed. In old or debilitated subjects, whose recuperative powers have gone, serious complications not infrequently supervene, and add greatly to the original risks.

In early manhood, provided there is no other constitutional weakness, a favorable prognosis may be given in cases in which a systematic early and prolonged course of treatment can be assured. But though treatment can modify syphilis, it cannot always eradicate it ; nor can it be depended upon to entirely ward off the constitutional symptoms which sooner or later almost certainly follow a primary chancre-infection. Before attempting a prognosis a good history of the case from the very commencement must be had. Patients sometimes will not tell the truth ; sometimes they do not know the truth. Some are observant ; some are indifferent ; a few purposely mislead the surgeon.

Speaking broadly, it is safe to say that a hard chancre will be followed by secondary symptoms ; and that during this secondary period the patient is highly infective. Whether and to what extent later (tertiary) symptoms will supervene will depend in large measure on the treatment that is or has been adopted. If an early mercurial treatment is conscientiously carried out by the patient, his secondaries may prove almost nominal, and he may entirely escape all tertiaries. Some patients who appear to be having a mild attack believe themselves well, and leave off treatment too soon ; an error of judgment for which they may have to pay dearly. A patient should not consider himself well for at least two years from the commencement of his attack, even though he have systematic treatment, and no symptoms have manifested themselves for six or eight months.

A child who may have accidentally been contaminated needs even a longer course of treatment, for the growing tissues of the young prove a most favorable culture-medium for the syphilitic virus, and special efforts will have to be made to eradicate it. The occurrence of other diseases must always be taken into account ; and perhaps the most serious complication of all is disease of the kidneys, for these nephritic subjects tolerate an antisyphilitic treatment, whether by mercury or iodid, very badly. If a tuberculous patient gets syphilis, the prognosis as to the syphilis (its infectivity and duration) is almost the same ; but there is a superadded difficulty, dependent on the tuberculosis, on its extent, and on the organ affected ; and so with other intercurrent diseases.

In hereditary syphilis a cautiously favorable prognosis can be given in a majority of the cases which survive for from four to six months.

The severest cases die quite young, and it must be confessed that the mortality is very great. The earlier the outbreak of the initial symptoms, the more severe the type of the disease and the greater its mortality. When syphilis manifests itself after the first eight or ten weeks of life, it usually proves very amenable to treatment: when it occurs still later, it is seldom dangerous to life unless some vital organ be attacked and neglected. In so-called late syphilis the danger to life is far less than the danger to individual organs: on the other hand, treatment is not usually very successful. The birth of syphilitic children proves active syphilis in the parents, one or both, though they may show no outward sign of their taint, and calls for further antisyphilitic treatment, in order to safeguard any further offspring that may be born to them.

Effects of Injury.—Injuries sometimes wake up latent syphilis, or recall it into activity. The bone-lesions of the tertiary period not uncommonly commence after a slight blow, as, for instance, a kick on the shin. Disease of the tongue is frequently started and kept up by sharp, decayed teeth, by the irritation of hot or overspiced foods, by alcohol, or by tobacco. The early lesions of hereditary syphilis also are frequently determined and always greatly aggravated by external irritations of one kind or another.

Second Attacks.—Second attacks of syphilis are undoubtedly met with; though the cases are relatively few and far between. There is nothing very remarkable about such a circumstance, especially if the first attack has been adequately treated. Indeed, these second attacks in subjects who expose themselves to new infection appear to the writer to prove that syphilis is a curable disease; for so long as the syphilitic virus remains in the system, it protects its host against further attacks. Seeing the marked influence which mercury exercises on syphilitic lesions, it is not difficult to imagine that it effects a complete cure in some few cases; and so it is only to be expected that second attacks should occur from time to time.

Should Isolation be Insisted On?—The long-continued infectiveness of syphilis, even after all external lesions may have disappeared, renders precautionary measures of the utmost importance. As often happens, a young man, living at home with his parents, brothers, and sisters, unfortunately acquires syphilis. What is to be done? Is the surgeon to hide the fact or to make a clean breast of it? Can a man be safely allowed to mix with his family? Should a man kiss either mother or sister under such circumstances? Can he have all that attention and that thorough treatment which are desirable as long as the real nature of his disease is kept secret? Is he to continue in business and mix with his companions while the subject of a highly contagious malady like syphilis? If an accidental infection occurs, in what position would the practitioner stand who had kept silence? It is not possible, within the narrow limits of this chapter, to discuss these great social problems. Both doctor and patient must bear in mind the contagious nature of the blood and secretions of a syphilitic for long periods after the primary infection, and take every possible precaution to prevent the occurrence of misfortune.

Marriage.—When is it safe to marry? For how long after an

attack of syphilis should a man refrain from marrying? This question is one of the most important that can possibly be raised. It is well known that the sexual excitement of the early months of married life often leads to a recrudescence of the disease, sometimes even after a long and careful course of treatment. Most surgeons are cognizant of painful instances in which this has occurred. Under the most favorable circumstances a period of two full years should elapse between the original infection and marriage; and at least twelve months should elapse between marriage and the last recognizable symptom. It should be further laid down that these are the minimum periods, and that a thorough course of treatment has been gone through. Even where no symptoms have presented themselves, it will be wise and proper as a precautionary measure to recommend a mild mercurial course during the two or three months immediately preceding the marriage, if it is decided to marry at these minimum periods.

Treatment of Syphilis.—The great antidote to syphilis is mercury: in patients of all ages and in all stages of the disease, mercury is the sheet-anchor. The more active and unadulterated the syphilis, the more obvious becomes the beneficial effect of mercury on the disease. If it were possible to recognize with certainty a primary sore before induration had taken place, the administration of mercury would in all probability cut short the disease absolutely. In doubtful cases some practitioners even withhold mercury, in order not to interfere with the development of symptoms, with a view to a correct diagnosis; but it is very much safer to remain in doubt than to allow such a hateful disease to get foothold; it is much easier to let syphilis in than to eradicate it, once it has gained admission, even with such a powerful ally as mercury to rely upon.

The cases in which mercury in any form disagrees are very few and far between: if found, it is chiefly during the late stages, when the constitutional powers of the patient are weakened by causes other than syphilis proper. Nevertheless, individuals show a very varying susceptibility to the drug, a fact which must always be remembered when prescribing it. Fortunately, there are many ways of administering the drug; and when one method fails another can always be tried.

It may be laid down as a canon that mercury, to be really effectual in syphilis, must be given in small doses, and that its administration must be continued for long periods. A "small dose" is a somewhat relative expression, for an amount which one patient tolerates perfectly may cause considerable irritation in another. Moreover, mercury belongs to the class of drugs which exert a cumulative action; by which is meant that for a while the dose may appear to exert little or no effect, and then suddenly the action of the drug begins to manifest itself in a very intense form. This action is sometimes set in action by other drugs. Thus, in a case with late secondaries, mercury in small doses had been given for some time without much effect, good or bad; so iodid of potassium was substituted, and within three days the most profuse salivation occurred.

As a rule, adults are more susceptible to mercury than children; the latter bear the drug remarkably well; even young infants tolerate a long *mild* course without any detriment, and they may even grow fat

on it. It is not improbable that the milk-diet, on which infants and children largely live, forms compounds with the mercury which lessen the irritant effects that the drug sometimes exercises on older people, a fact which suggests the possible advantages of milk as an article of diet for adults undergoing a mercurial course. Mercury internally is better borne when administered shortly after food; it then gets thoroughly mixed with the food during digestion, while the process of absorption is active, and smaller quantities seem to suffice.

Sooner or later mercury produces **salivation**; but this occurs very gradually, and is preceded by swelling and tenderness of the buccal mucous membrane. Its onset is a useful indication that the system is well under the influence of the drug, and that its further administration ought at once to be suspended for a while or the dosage lessened. And while salivation, as a rule, is to be carefully avoided, it is well to recognize the fact that in a small minority of cases the cure only begins and proceeds after the gums have been affected.

A very necessary part of a mercurial treatment is to give special attention to the mouth and teeth, particularly in cases in which the teeth are not sound. After carefully brushing the teeth with an antiseptic saponaceous tooth-powder, the mouth should be well gargled several times in the day with an alum gargle containing a little glycerin. With such precautions, mercury may often be administered to a syphilitic patient for weeks or months together without the slightest inconvenience. There is a popular belief, and one that is well founded, that a patient undergoing a mercurial course is specially liable to "take cold" and to illness. Certainly this is not the time to trifle or neglect one's self. The patient, on the contrary, should take extra care of himself; live a quiet, steady life, and àvoid excesses, whether in exercise, food, alcohol, tobacco, or otherwise; and go about warmly clad.

The following are some among the many methods of administering mercury to syphilitic patients. Each practitioner must choose for himself that or those which seem best adapted to the circumstances of an individual case. The writer has often found it convenient, as well as advantageous, to change and change about.

One of the best mercurial preparations for primary syphilis is the "*gray powder*" (hydrargyrum cum cretâ) of the British Pharmacopœia: it may be administered in doses of 1 grain and upward, preferably combined with an equal quantity of Dover's powder (pulvis ipecacuanhæ compositus), either in the form of a pill or as a powder. The dose should be taken shortly after a meal, three or four times in the twenty-four hours. If found to agree, the dose may be increased, so as to get the patient as rapidly as is safe under mercurial influence, which will be accomplished in about a week. After this the smaller dose should be resumed, and, if needs be, intermitted from time to time. Should diarrhea or other irritation of the bowels be experienced, the mercury must be stopped for a day or two, or the dose of Dover's powder be slightly increased. These mercurial pills have the merits of remaining practically unchanged for any length of time; the dosage is accurate and easily regulated, and they are very portable.

As a local application to a hard chancre, a dusting-powder composed of 3 parts of zinc oxid and 1 part of calomel, carefully

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rubbed together, will be found very efficacious; the powder may be applied with a soft, long-haired brush or with a pledget of absorbent wool. For mixed sores with an unhealthy surface black wash (lotio hydrargyri nigra) is very useful. Should sloughing (phagedena) occur, frequent or prolonged sitz baths containing some suitable antiseptic solution are indicated during the day; the blackwash dressing being resumed at night. The sore, having been well cleansed, should be covered with sterilized gauze soaked in the lotion; this dressing should be frequently repeated.

Inunction is a somewhat dirty but a very efficacious method of employing mercury; it is rather less easy to regulate the dose, but if the effects are carefully watched, no harm need result. From 1 to 2 drams of blue ointment (unguentum hydrargyri) should be thoroughly rubbed every morning into some soft part of the skin—the groins, the axillæ, the front of the thighs, or the abdomen, in turn, so as to avoid local irritation. This may be done by the patient himself or by an attendant, who must use a glove or a pad especially adapted to the purpose. Lanolin may advantageously be substituted for lard in the manufacture of the blue ointment. During the secondary stage, while the skin is liable to be involved, the inunction treatment is rather contra-indicated, or must be practised with an attenuated ointment.

The *calomel vapor bath* is a very valuable means of bringing the patient rapidly under the influence of mercury without irritating the gastro-intestinal tract; it is also especially indicated when the secondary skin affections are severe. From 10 to 30 grs. of calomel are volatilized over a lamp placed beneath a chair on which the patient sits nude, with a long mackintosh cape tied round the neck and falling to the ground, so as to shut in the vapor. This "bath" should last for half an hour, and be taken every night or every second night.

In the cases in which there are moist eruptions, the dusting-powder already mentioned may be used. If the mouth or pharynx is much affected, the alum gargle will prove a useful astringent. Sometimes "yellow wash" (lotio hydrargyri flava) will prove useful in obstinate cases; this latter must not be swallowed, and therefore should only be used under direct supervision. A solution of chromic acid (2 per cent.) is a very valuable application to secondary sores—cracks and papules on the mouth and throat; it should be lightly painted on once a day.

Great care should be exercised not to irritate any syphilitic eruptions by too powerful local applications; on the other hand, an occasional stimulation will prove useful in indolent sores. General cleanliness of the whole body is specially indicated; frequent warm baths containing some mild antiseptic and disinfectant will always prove useful during a mercurial course of treatment.

During the tertiary period mercury must be used with greater caution. The further in point of time a lesion is removed from the primary infection, the less is mercury a specific, and the greater the need for some ally to assist it. This is found in iodin. In the form of potassium iodid, sometimes alone, sometimes combined with mercury perchlorid, this drug is most valuable in the late period, especially so when the bones and periosteum are much affected. The excruciating pain sometimes experienced yields to this remedy, and usually very

readily. When the iodid is substituted for mercury after a long course of the latter, it should be commenced cautiously, for salivation occasionally sets in. The dose of iodid must occasionally be very large before any benefit from its use occurs. Ten to 25 grains may be given —with perhaps 15 grains as an average—three or four times a day; either ammonium carbonate (5 grains) or the aromatic spirit of ammonia (½ fluidram) being combined with it, in a *plentiful supply of water.* The smaller doses should be tried first. If combined with mercury, 5 grains of the iodid with $\frac{1}{18}$ grain of mercury perchlorid would be an average dose with which to commence.

In the ulcerating or sloughing and serpiginous lesions of the tertiary period a Volkmann's sharp spoon and a pair of scissors will render invaluable service, the patient being under an anesthetic. Deep ulcerating gummata should be scraped away; and any neighboring parts which may have been involved in the destructive process may be cleaned up with curved scissors, and shreds of tendon or thick fascia trimmed off. The parts can then be soaked with some antiseptic fluid and subsequently treated *secundum artem.* The constant bath, containing a little lysol, creolin, or other disinfectant, is another powerful helper in cases (*e. g.*, the genitals) in which the scissors or sharp spoon cannot be easily employed.

In debilitated subjects tonics should be given with the specifics. Thus, quinin, iron, arsenic, and strychnin, in suitable doses and combinations, often prove of the greatest service. Cod-liver oil, when tolerated, is both a food and a medicine, and should be tried in suitable cases, for adults as well as children.

In treating children suffering from congenital syphilis, gray powder will prove a most valuable preparation. It may be mixed with a little powdered white sugar, and dropped upon the tongue in 1-grain doses, three or four times a day, according to circumstances, with or without Dover's powder. Or, for children among the poor, who cannot be assured of the necessary care, a modified form of inunction will be found efficacious. A little mercurial ointment is spread upon one end of a broad flannel bandage, over an area sufficient to cover the child's abdomen, to which it is applied, and the remainder of the bandage is wrapped round two or three times; the child's movements suffice to rub in the ointment, which should be renewed two or three times a week. Great cleanliness is necessary, and a free use of dusting-powder should be made after each bath and each change of diaper. An excellent dusting-powder is made of powdered starch, 3 parts; zinc oxid, 3 parts; calomel, 1 part; well rubbed together, with a few drops of eucalyptus oil. Finally, one little caution as to the use of mercury in these cases: *Give enough, but the less the better!*

Intramuscular Injection.—A new method of employing mercury has recently been introduced, and is now largely used in the army, for a full account of which the reader may refer to the British Army Medical Report for the year 1898. This method of intramuscular injection is said to be very effectual, and to be easily carried out. The men need not be admitted into hospital nor taken away from their ordinary duties, as it involves but a short attendance once a week, each time an injection is practised. During the acute primary stage the usual older

methods of treatment are adopted. This intramuscular method is only advocated later on, when it is necessary to keep the patients well under the influence of mercury in the safest and least troublesome way possible. At first a carbolized lanolin cream containing finely divided metallic mercury is used; then other preparations of mercury. The injections are usually made into the gluteus maximus muscle. Sterilizing precautions as to cleanliness of the skin and of the instrument must, of course, be taken.

Intravenous injections of a solution of bichlorid of mercury are also used and advocated by some authorities.

Diet, etc.—Insufficient and improper food and overcrowded and unsanitary surroundings are largely responsible for much that is disastrous in all the stages of syphilis. The beneficial effects of cleanliness, good diet, regular and systematic living, when poor patients are admitted into hospital, often become evident within a few hours. On the other hand, there is occasionally a tendency on the part of medical practitioners to cut off rather too suddenly the wine and other luxuries of their better-class patients, and to be too rigid as to what may or may not be taken. *Syphilitic patients,* however, *need a good diet;* those who have become habituated to wine and other luxuries perhaps need not be deprived of them. A medium course in this, as in other circumstances, is the safe one. Excess certainly does harm.

CHAPTER XXVII.

SURGERY OF THE EYE.

AFFECTIONS OF THE CONJUNCTIVA.

Congestion or Hyperemia.—Hyperemia of the conjunctiva may result from various causes, among which are a foreign body in the eye; impurities of the atmosphere; exposure to heat, glare, smoke, or dust; want of sleep; alcoholic excesses; and straining of the eyes for near work, with uncorrected errors of refraction.

The **symptoms** of which patients complain are heat of the eyes and a sensation of grit in them; there is usually an increased flow of tears.

The **treatment** consists in the removal of the exciting cause. When patients have to be exposed to impure states of the atmosphere, heat, or glare, protective glasses of a suitable shade of neutral tint should be worn. A solution of boric acid, 2 per cent., makes an excellent lotion for this affection. In chronic cases, astringent drops of zinc sulphate, 1 : 250, should be prescribed.

Inflammation.—Inflammatory affections of the conjunctiva present themselves under many different forms. An inflammation of this membrane may come on rapidly, with intense injection involving both its ocular and palpebral divisions; or the onset may be gradual and the injection confined to one part.

In some acute cases the ocular conjunctiva, by the effusion of serous fluid into it, becomes much swollen, a condition termed *chemosis*. Not uncommonly there are hemorrhages into the ocular conjunctiva, which, being situated near the surface, readily become oxygenated, and assume a bright-red color.

There is a localized form of inflammation, occurring in the limbus, or anterior part of the ocular conjunctiva, characterized by the efflorescence of circular nodules the size of millet-seeds, which are surrounded by enlarged blood-vessels, and called *phlyctenular ophthalmia*. After a short time these nodules frequently break down and form small gray ulcers—*phlyctenular ulcers*. The discharge from the conjunctiva, when it is inflamed, varies in both amount and character. It may be copious, and overflow through the palpebral aperture; or slight in amount, only just sufficient to glue the eyelids together during sleep, or to form a little yellow flake which collects at the inner angle of the lids over the caruncle. The discharge may consist of creamy yellow pus—*purulent ophthalmia*; of flakes of yellow sticky mucopus—*catarrhal ophthalmia*; or of a thin watery fluid—*chronic conjunctivitis*. In some cases the discharge coagulates on the inner surface of the lids, forming a grayish membrane. This membrane may be easily wiped away without any bleeding—*simple membranous ophthalmia*; or it may adhere firmly

to the lid, which is then generally thickened and brawny, and when removed leave a bleeding surface—*diphtheritic ophthalmia.*

Some forms of inflammation of the conjunctiva are associated with a growth of lymphoid adenomatous tissue. This may consist of an enlargement of the lymphoid nodules, which are normally present in the conjunctiva of children's eyes. There are then seen what look like little strings of small clear beads in the lower fornix—*follicular ophthalmia.* In other cases there is considerable new formation of lymphoid tissue in the palpebral conjunctiva and retrotarsal folds. It gives rise to a granular condition of the surface, and forms nodules which frequently have the appearance of grains of boiled sago—*granular ophthalmia, trachoma.* One variety of inflammation of the conjunctiva presents the remarkable characteristic of disappearing in the cold weather and reappearing each spring. In it there are seen in the palpebral conjunctiva, and sometimes also at the limbus, flattened papillary outgrowths, having a bluish-white appearance on the surface, due to thickening of the epithelium : this variety is known as *spring catarrh.*

Ophthalmia Neonatorum.—The ophthalmia of newborn children is generally purulent in character, due to infection of the child's eye from a vaginal discharge in the mother during birth. In the majority of cases the gonococci can be detected in the discharge. It varies much in its intensity ; but is usually accompanied by considerable swelling and injection of the palpebral conjunctiva. The disease commences the second, third, or fourth day after birth, both eyes being generally affected at the same time. It is exceedingly liable to become complicated with ulceration of the cornea, and requires energetic and careful treatment. It has been estimated that of the inmates of blind asylums, 30 per cent. have lost their sight from this disease.

Gonorrheal Ophthalmia in the Adult.—Gonorrheal ophthalmia in the adult varies in intensity according to the condition of the infective secretion inoculated. It has been shown experimentally that its strength can be weakened in various ways. It is probable that a chronic gleety discharge will not give rise to such a severe attack as the fresh pus from a gonorrhea of only a few days' standing. In the most severe cases, within a few hours of inoculation there are intense swelling, heat, redness of the lids, and chemosis. In the course of about two days the swelling subsides, and a copious purulent discharge commences. Owing to the swollen condition of the ocular conjunctiva, ulceration of the cornea is exceedingly liable to occur.[1] Usually only one eye is at first involved in purulent ophthalmia ; but the second is very liable to become infected from the first.

When a surgeon sees a case, should only one eye be affected, he ought at once to take precautions to protect the other one. This is best done by the application of what is known as a Buller's shield, which consists of a watch-glass sewed into some waterproof material. It is placed over the sound eye, and made adherent to the nose and forehead with plaster.

Acute catarrhal ophthalmia is a highly infectious disease, which may involve only the palpebral or both the palpebral and ocular conjunctivæ. It affects persons of all ages. An attack generally runs a definite

[1] See ulceration of the cornea in connection with ophthalmia.

course, subsiding spontaneously in less than a fortnight, though it occasionally becomes chronic. Both eyes are usually affected; though the attack often commences later in one eye than in the other. Patients complain of pain, a feeling of stiffness and heat about the eyes, photophobia, lacrimation, and gumming of the lids together by secretion during sleep.

Membranous and Diphtheritic Ophthalmia.—True diphtheria may undoubtedly attack the conjunctiva, paralytic symptoms resulting. Membranous inflammation of the conjunctiva, not diphtheritic, may undoubtedly occur. The formation of a membrane may be excited by the too energetic application of silver nitrate to the conjunctiva. The severe cases of diphtheritic ophthalmia can be readily diagnosed by the thickened, brawny condition of the lids. In mild cases of ophthalmia in which a membrane is present, the difficulty in excluding the possi-

FIG. 416.—Purulent ophthalmia of the left eye; a Buller shield applied over the right eye, to guard it from infection.

bility of its being diphtheritic is often very great. The throat should always be examined. The presence or absence of cases of diphtheria in the same house as the patient, or in the vicinity, should be inquired into, and the bacillus of diphtheria sought for in the membrane.

Phlyctenular ophthalmia is a disease most frequently met with in strumous children, and one which frequently has a tendency to relapse until after the age of adolescence. The first onset of the disease often dates from a time when the child's health had become debilitated by an attack of measles, scarlet fever, or whooping-cough. It is usually accompanied by a great deal of lacrimation, photophobia, and blepharospasm. Sometimes, so great is the spasm that the examination of the eyes and the application of remedies to them become matters of extreme difficulty. The millet-seed-like efflorescences may be confined to the ocular conjunctiva; at times they spread from the limbus on to the surface of

the cornea, leashes of blood-vessels connecting them with those of the conjunctiva.

Conjunctivitis Excited by Drugs.—In certain individuals, drugs which may be used with impunity by others will cause inflammation of the conjunctiva. Atropin and eserin, applied locally to the eye, are liable to act in this way. Arsenic taken internally will, in some people, cause an acute inflammation of the conjunctiva, with much injection and lacrimation. An infusion made from jequirity-seeds, applied to the conjunctiva, produces an acute inflammation with considerable swelling of the lids, and sometimes the formation of a membrane. It is due to the presence of a pepsin-like ferment.

Trachoma, or **granular ophthalmia,** is a disease which tends to spread with great rapidity in communities where precautions against infection are not taken. It is exceedingly prevalent in the hot, dry, sandy countries of the East, as well as in such a low-lying, moist country as Ireland. The habits of a people, seemingly, have more influence in its dissemination than any particular climatic condition.

An attack may commence with varying degrees of acuteness. Sometimes it begins with purulent discharge, swelling of lids, redness, and photophobia; at other times it sets in very insidiously with scarcely any discharge or excess of secretion; it may even exist for a considerable time without attracting the patient's attention.

In these chronic cases one of the first symptoms noticed is a slight drooping of the upper lid, and a peculiar heavy appearance of it, due to thickening of the palpebral conjunctiva from the growth of lymphoid nodules. The course of the affection may extend over a number of years, the patient being liable from time to time to acute exacerbations of inflammation.

The lymphoid nodules which give rise to the granular condition after a time become replaced by cicatricial tissue, which forms dense white lines in the conjunctiva. It is the contraction of this cicatricial tissue which causes inturning of the margins of the lids, or entropion, a very common sequela of trachoma.

Other complications of the disease are vascularity of the cornea, or pannus, and ulceration of the cornea.

Follicular conjunctivitis occurs mostly in children. It is important to distinguish it from trachoma, as in it the enlarged follicles become absorbed without the formation of cicatricial tissue and the consequent disastrous results. The symptoms complained of are lacrimation, photophobia, and a gritty sensation in the eye. Sometimes the irritation causes the patient to be continually blinking. The lymphoid follicles of the conjunctiva are frequently not the only ones affected; on examination, those of the pharynx will also be found enlarged.

Spring catarrh is also an affection which occurs mostly in children. It is of an exceedingly chronic character, making its appearance regularly year after year as the warm weather sets in. The thickening at the limbus of the cornea is not always present; but sometimes it is very marked, encroaching on the cornea. Both eyes are usually involved, and the patient complains of an itching sensation of the eyes.

Treatment of Inflammatory Affections of the Conjunctiva.—The most useful drug in the treatment of *purulent conjunctivitis* is silver

nitrate. It is best applied in the form of a solution, 1, 2, or 3 per cent., according to the severity of the case. The eyelids should be everted, the discharge wiped away, and the solution painted on with a camel's-hair brush over the whole surface of the palpebral conjunctiva once every twenty-four hours. In addition to this, the discharge should be washed away about every hour with an antiseptic astringent lotion, such as zinc-chlorid lotion, 1 : 500; and an antiseptic ointment, boric-acid ointment, should be applied to the margins of the lids, to prevent them becoming stuck together with discharge.

In the early stages of purulent ophthalmia in an adult, before the discharge has become copious, the constant application of iced pads affords great relief from pain, and tends to reduce the swelling of the lids and the chemosis. Should the chemosis be so great as to threaten
• strangulation of the lymph-supply of the cornea, it is well to make several incisions into the ocular conjunctiva, radiating from the cornea.

In wiping or syringing away discharge, great care must be taken to avoid making any abrasion of the corneal epithelium, because the denuded spot will become infected and destructive ulceration result. Surgeons and nurses, while treating cases of purulent ophthalmia, should be cautious not to inoculate their own eyes. If syringing of the eyes is resorted to, protective glasses should be worn by them.

The treatment of *diphtheritic* or *membranous ophthalmia* is much the same as that for purulent ophthalmia. In the early stages ice-compresses and antiseptic lotions should be applied; and later, when discharge has begun to form, a solution .of silver nitrate should be painted on the inner surface of the lids.

In *acute catarrhal ophthalmia* bathing of the eyes and application to the conjunctival sac of an antiseptic lotion, such as mercuric-chlorid lotion, 1 : 4000, every three hours, usually effect a speedy cure. The adhesion of the lids during sleep should be prevented by the application of unguentum acidi borici to their margins. In the more chronic forms of conjunctivitis, astringent lotions or drops are required, such as zinc-sulphate drops, 1 : 250.

In *phlyctenular ophthalmia* the eye should be bathed with an antiseptic lotion, boric-acid lotion or mercuric-chlorid lotion, 1 : 4000; and an ointment containing the yellow mercuric oxid, 1 : 125 or 1 : 60, should be inserted into the lower conjunctival cul-de-sac, with a camel's-hair brush, three times a day. It may be combined with atropin if the cornea is affected. Some chronic cases do well with a little calomel dusted into the eyes once daily. The patient's general health usually requires treatment with preparations of iron, or arsenic, and cod-liver oil. A shade or dark glasses should be worn, and when the photophobia is intense or persistent, blisters applied to the temples often give relief.

In *granular ophthalmia* the two points to which treatment has to be directed are the limitation of any undue amount of inflammation and the absorption of the lymphoid nodules. The best remedy for these purposes is the touching of the conjunctival surface of the lids with caustics, such as copper sulphate or lapus divinus, or the painting of the lid with a 2 per cent. solution of silver nitrate.

To effect complete cure, the application of these remedies has to

be kept up regularly once a day for some months. The silver nitrate, if used too long, is liable to give rise to permanent staining of the conjunctiva. It is best suited for cases in which there is much secretion. Copper sulphate should be substituted for it when the discharge has stopped.

The course of a case of granular ophthalmia can sometimes be much shortened by expression of the nodules of lymphoid tissue with forceps. The lid is everted, and a fold of the fornix of the conjunctiva grasped with a pair of curved forceps specially designed for the purpose, and called Grady's forceps. The fold of conjunctiva is then compressed by slowly drawing the forceps forward, and any lymphoid tissue is squeezed out. The process is repeated wherever lymphoid nodules are seen. Should there be complete pannus of the cornea without ulceration and not much discharge, which is not uncommonly the condition in old-standing neglected cases of granular ophthalmia, an acute attack of inflammation will sometimes produce marked clearing of the cornea and improvement in vision. Such an acute attack can be excited by the application of a freshly made infusion of powdered jequirity-seeds.

In *follicular conjunctivitis* the best local application is the mercuric-chlorid lotion, 1 : 4000. The patient's general health must be attended to, any error of refraction carefully corrected, and any defect in his hygienic surroundings removed.

Spring catarrh is a complaint that is most intractable to treatment. There is nothing known which will prevent recurrence of the attacks: but after a while they cease spontaneously. The irritation while the attacks last is best relieved by bathing the eyes with a weak carbolic-acid lotion, 1 : 100.

Xerosis of the Conjunctiva.—An undue dryness of the conjunctiva manifests itself by a lack-luster, opaque, whitish appearance of the membrane, and the collection of a kind of froth or foam on its surface.

The condition may be localized or involve the whole of the conjunctiva together with the cornea, which likewise loses its transparency.

Xerosis of the conjunctiva is caused by conditions which keep its surface exposed permanently to the air, such as ectropion and cicatricial changes resulting from granular ophthalmia, or a peculiar vesicular disease of the conjunctiva which has been termed pemphigus.

In the latter class of cases, though the xerosis begins as a localized affection, it progresses in spite of all treatment until the whole of the conjunctiva and cornea become involved.

A localized form of xerosis, which affects triangular areas of the conjunctiva on each side of the cornea opposite the palpebral aperture, is met with in children and is often associated with night-blindness. Generally the affection passes off without giving rise to other symptoms; occasionally in rare cases it has been known to extend, the cornea becoming involved in a suppurative affection and the children dying of a general disease.

Thickenings and New Growths of the Conjunctiva.—The portion of the ocular conjunctiva which corresponds to the palpebral aperture is necessarily more exposed than the rest of its area. In those who live in countries where there is much wind and dust, or whose occupations cause them to be exposed more than usual to these agencies, there is a tendency for the interpalpebral portion of the conjunctiva to undergo a form of degeneration and thickening, which shows itself as a little yellowish raised patch, and is called *pinguecula*.

The same sort of degeneration is liable to extend into the cornea, and then the conjunctiva in the interpalpebral area becomes drawn on to the

cornea as a triangular fold—*pterygium.* These triangular folds of con-
junctiva tend to grow further and further toward the center of the cornea,
and when they invade the pupillary area interfere with vision. Some-
times they become avascular, turn white, and cease to advance. Neither
a pinguecula nor a pterygium is met with in early life; they most fre-
quently form on the inner side of the globe, but may also occur on the
outer.

Treatment.—Pingueculæ require no treatment. A pterygium, if
progressive, must be operated on. A snip should be made in the con-
junctiva, near the corneal margin, at the upper and lower borders of
the growth. A strabismus-hook is then passed through the openings
between the growth and the sclerotic. By fixing the globe with forceps
and drawing the hook toward the cornea, the apex of the pterygium can
be drawn away and separated from the cornea. Its apex must next be
cut off, and the conjunctiva from above and below united by sutures.

Thickenings and ulcerations of the palpebral conjunctiva, are met
with in rare cases, and are due to tubercular nodules.

The conjunctiva may also be the seat of translucent, thin-walled
cysts originating in dilated lymphatic vessels; of papillomata, of sar-
comata, and of epitheliomata. A fibro-fatty growth, of congenital origin,
is sometimes met with at the upper and outer part of the globe.

AFFECTIONS OF THE CORNEA.

Inflammation of the Cornea.—Inflammation of the cornea is
sometimes limited to its superficial parts, and at other times to the
deeper substantia propria. In the first case the cellular exudation
which is thrown out is located between the surface-epithelium and the
anterior elastic lamina. The blood-vessels which then become pro-
longed into the cornea are derived from those of the conjunctiva which
terminate at its margin.

When the substantia propria is the seat of inflammation, the cells,
derived partly from proliferation of the fixed ones of the cornea and
partly from migration of leukocytes, accumulate in the lymph-spaces
between the laminæ of fibrous tissue. Then, when vascularization
occurs, the new vessels grow from the ciliary blood-vessels.

These two forms of vascularization of the cornea can be differentiated
clinically as follows : In the form derived from the conjunctival vessels—
pannus—the separate branches are easily distinguished on the surface of
the cornea, passing over the margin and continuous with those in the
limbus of the conjunctiva. In that derived from the ciliary vessels the
branches are barely distinguishable, run parallel to one another, and are of
much duller color, on account of the amount of tissue in front of them.

The superficial form of inflammation is met with in connection with
phlyctenular and granular ophthalmia ; the deeper form, in connection
with syphilis, tubercle, and the acute specific fevers.

Inflammation beginning either superficially or deeply frequently
spreads so that both parts become involved. After injuries of the
cornea both parts are often affected at the same time. The superficial
form is most likely to lead to ulceration ; the deeper form, to iritis and
cyclitis.

Syphilitic Interstitial Keratitis.—This is a form of inflammation of the cornea in which there is no tendency to ulceration. It commences with a grayish haze situated deep in the cornea and with a loss of the superficial polish. The opacity may commence at one place, near the center or at the margins, or in several spots which subsequently coalesce. Sometimes the whole cornea will become opaque like ground glass; at other times only a portion of it is involved. Soon after the opacity has commenced, blood-vessels creep into the cornea from the ciliary vessels ; the part of the cornea which then becomes vascularized presents a dirty grayish-red appearance.

After the opaque portion of the cornea has become vascularized it slowly clears again and the vessels gradually disappear. Permanent faint nebulæ are, however, frequently left, and faint lines showing the tracks the blood-vessels traversed can generally be detected on high magnification years afterward.

The duration of a case from the time the opacity first appears until the cornea has cleared to its maximum amount varies from a few months to two years.

There is nearly always some ciliary injection, frequently some iritis, and in the majority of cases, if careful examination is made after the opacity has cleared up, one or more patches of choroidal atrophy will be discovered.

Interstitial keratitis is an affection which occurs most frequently in the second decade of life ; it is exceedingly rare before five or after thirty.

The patients in whom it occurs are generally the subjects of inherited syphilis, who present the usual dental and physiognomical characters of that disease, and who on inquiry relate a typical, or suggestive, family history. It does, however, occasionally occur in connection with acquired syphilis.

Treatment.—No known treatment will cut short an attack of interstitial keratitis, and attention must chiefly be directed to combating the complications which may arise in association with it.

Bathing the eyes with hot boric-acid lotion tends to relieve the pain and irritation sometimes complained of.

The pupil should be kept dilated with atropin during the whole course of the attack— *i. e.,* until all the vascular injection has subsided. An ointment of the alkaloid, 1 per cent., made up with vaselin, should be put into the eye with a camel's-hair brush three times a day. In this way the formation of adhesions between the iris and lens may be avoided.

In the later stages, when the inflammation has ceased and when there is still some opacity left, yellow-oxid-of-mercury ointment or calomel should be used to stimulate absorption.

Mercury is very frequently prescribed in the form of gray powder to be taken internally ; but it is very doubtful if it has any influence on the course of the affection.

A tonic treatment with cod-liver oil and iodid of iron, on account of the marasmic condition of the patient, is often called for.

Ulcers of the Cornea.

—Ulcers of the cornea vary considerably according to the amount and character of the exudation accompanying them, their mode of spreading, their mode of healing, and the complications to which they give rise.

In some cases the exudation from the surface and into the corneal tissue around is purulent in character, constituting *suppurating ulcers.* An irregular depressed area is then seen in the cornea, discharging pus and surrounded by a yellow ring of opacity. The microorganisms most frequently met with in the discharge from such ulcers are the pneumococci and streptococci, and they seem to be the infecting agents (Uhthoff and Axenfeld).

In other ulcers the exudation is more catarrhal than purulent in character, and the exudation into the corneal substance around them gives rise to a gray-colored opacity—*gray ulcers.*

In another class of cases there is destruction of tissue with scarcely any infiltration, so that the base of the ulcer and the tissue around remain transparent. The cornea appears then just as if a piece had been shaved off or chipped out of it—*clear* or *torpid ulcers.*

Ulcers of the cornea may spread widely or deeply. Frequently they tend to spread in one direction by a crescentic, undermined, sup-

purating margin; while the part first affected heals and clears—*serpiginous* or *creeping ulcers.*

There is a variety of corneal ulcer which has the form of a stem out of which buds and branches protrude, and which spreads superficially by the formation of fresh buds and branches—*dendritic ulcers.*

When in an ulcer the dead tissue is thrown off, the epithelium spreads over the surface, some of the infiltrating cells return to the circulation, and others lengthen out, forming fibrous tissue to replace that which has been destroyed. The opacity in this way tends gradually to clear up, the amount which is left depending on the character of the ulcer and the extent of the tissue destroyed.

If only a faint-gray opacity is left, it is spoken of as a *nebula of the cornea;* if the opacity is dense and white, as a *leukoma.* Very dense white opacities are produced if lead lotion is applied to the eye when there is an abrasion of the epithelium or an ulcer, due to the deposit of the white carbonate of lead. In the torpid ulcers of the cornea sufficient exudation is not thrown out to replace the tissue which has been destroyed, and so when they have healed a faceted surface is left.

Suppurative ulcers of the cornea are frequently associated with an accumulation of yellow exudation in the anterior chamber, which collects at the lower part, and is termed a *hypopyon.* This yellow exudation is not derived directly from the suppurative process going on in the cornea, but is thrown out by the iris and ciliary body, which become inflamed secondarily to the keratitis.

Ulcers of the cornea are generally accompanied by some, and the severer forms by considerable, injection of the conjunctival and ciliary blood-vessels. In most cases there are photophobia, pain in and around the eye, lacrimation, and, if the ulcer is near the center of the cornea, some disturbance in vision.

Should an ulcer of the cornea perforate, the aqueous humor escapes, and the iris and lens come forward into contact with the inflamed surface; adhesion of either of these structures to the cornea is then very liable to occur, forming an *anterior synechia of iris or lens.* If the perforation is large and occurs suddenly, the lens is liable to escape through it, or a portion of the iris to become prolapsed. Should a broad adhesion of the iris and cornea form, the advance in the position of the iris may be so great that the angle of the chamber becomes blocked and secondary glaucoma established (see Glaucoma).

If the whole of the cornea, or nearly the whole cornea, become destroyed by ulceration, as occasionally occurs in cases of ophthalmia neonatorum, then the iris is left exposed, from which masses of granulation-tissue grow out to fill up the gap. This granulation-tissue subsequently develops into fibrous tissue, forming a pseudocornea, which becomes densely white, and protrudes often so much as to project through the palpebral aperture and prevent closure of the lids over it. Ulcers of the cornea may be divided, according to their etiology, into the following classes. 1. Traumatic. 2. Those occurring in connection with ophthalmia. 3. Those occurring in the course of some febrile affection. 4. Neuropathic. 5. Marasmic.

Traumatic Ulcers.—Delay in the healing process of a wound of the cornea may occur from its contamination, either at the time of injury by some chemical or microbic poison on the wounding substance, or later, from some infective material in the conjunctival sac. Abrasions of the cornea which occur during the harvesting season from ears of wheat are especially liable to take on a troublesome ulcerative character, probably from some irritant situated on the abrading substance. An abrasion of the cornea in an eye in which there are lacrimal obstruction and regurgitation of pus from the lacrimal sac is almost sure to become infected, break down, and suppurate. The surgeon should be careful in all cases of suppurating ulcers to investigate the condition of the lacrimal apparatus, as the treatment of any trouble in it is a necessary preliminary to the cure of the ulcer.

Ulcers of the Cornea Occurring in Connection with Ophthalmia.—In purulent ophthalmia the two chief factors which cause ulceration are the lowered state of the nutrition of the cornea, due to the swelling of the ocular conjunctiva bringing about an arrest of the circulation in the capillaries at its margin, from which the lymph which circulates through it is derived, and the presence of the infective material in contact with it. The epithelium on the surface of the cornea in purulent ophthalmia soon becomes softened and hazy. In this

condition abrasions are easily produced, through which infective matter finds access. It would also seem that infection sometimes occurs through the unabraded epithelium, especially if the pus be kept pent up in contact with it, as it often is, by a fold of the thickened conjunctiva at the sclerocorneal margin. As already mentioned, ulcers of the cornea resulting from disintegration of the exudation which forms a phlyctenule, in the course of an attack of phlyctenular ophthalmia, is exceedingly common. These phlyctenulæ form at the margin of the cornea ; then when one has become converted into a small superficial ulcer, it often takes on a serpiginous character and spreads toward the center. A leash of superficial blood-vessels extends from the margin of the cornea to the ulcer along the line it has extended, and gives to this form of ulceration a very characteristic appearance.

Small ulcers which may join into one large one are met with in connection with granular ophthalmia at the margin of an area of pannus.

Ulcers of the cornea in connection with diphtheritic or membranous ophthalmia occur much in the same way as in purulent ophthalmia, and are generally rapidly destructive.

Ulcers of the Cornea in Connection with Some Febrile Affection.—Ulcers of the cornea in connection with some acute febrile affection may occur in several ways. In all forms of severe illness in which the patient lies for days unconscious, with the lids imperfectly closed, the cornea is liable to become abnormally dry in the exposed parts, and finally to break down and ulcerate.

Children, after an attack of measles or scarlet fever, are very liable to phlyctenular ophthalmia, which may, as stated above, result in ulceration of the cornea. In all the acute specific fevers abscesses of the cornea, metastatic in origin, which end in ulceration, are liable to form.

The ulcers of the cornea occurring in small-pox most frequently have their origin in this way, appearing during convalescence, not at the time of the formation of the pocks.

Neuropathic Ulcers.—When the cornea is rendered anesthetic by some affection of the fifth nerve, or in glaucoma by compression of the intra-ocular ciliary nerves against the sclerotic, ulceration not uncommonly ensues. At first the cornea loses its brilliancy, becoming cloudy ; then small vesicles form on its surface, and its epithelium may become easily rubbed off. Later, in some cases, an area of grayness forms near the center, which may break down into an ulcer, frequently accompanied by a hypopyon. These changes are probably due to the loss of trophic nerve influence.

In herpes zoster occurring in the course of the first division of the fifth nerve the cornea is liable to become involved. Small vesicles form on it, which rupture, leaving ulcers. The ulcers do not generally spread, but in addition to them there is often considerable gray infiltration of the substance of the cornea, which may persist, in spite of all treatment, as a permanent opacity.

Treatment.—In the treatment of ulcers of the cornea, attention must first be directed to the removal of any exciting cause, such as a foreign body or an inturned eyelash.

If the ulceration is secondary to, or has been infected by, some discharge from the conjunctiva or lacrimal sac, the appropriate treatment for those conditions, given elsewhere, must be carried out.

In all cases of ulceration of the cornea, with the exception of those in very young children, or where there is much conjunctival discharge, the eye should be kept tied up with a compress of cotton-wool and a bandage. The constant friction of the lid over the surface of the ulcer is thus prevented and healing promoted. Bathing of the eye with hot boric-acid lotion every four hours is suitable for most forms of ulcers of the cornea, especially for suppurating ulcers with hypopyon. Atropin, by its mydriatic properties, tends to relieve photophobia, and by its analgesic action relieves pain. Simple uninfected traumatic ulcers of the cornea heal rapidly if the eye is tied up, is treated with atropin, and is bathed from time to time with warm antiseptic lotion.

For infected or suppurating ulcers an ointment composed of precipitated iodoform 1 dram, the alkaloid of atropin 4 grains, made up with 1 ounce of vaselin, is often very efficacious.

If, in spite of the above treatment, an ulcer tends to spread, its advancing margin must be destroyed with the galvanocautery, or

touched with a strong solution of perchlorid of mercury, or with pure carbolic acid just liquefied.

Dendritic ulcers of the cornea are best treated with absolute alcohol rubbed into the affected area with a piece of lint.

In the torpid ulcers which require stimulation, an ointment containing yellow oxid of mercury 8 grains and the alkaloid of atropin 2 grains, made up with 1 ounce of vaselin, should be prescribed; or calomel may be dusted into the eye once or twice a day.

A yellow-oxid-of-mercury ointment, 4 grains to the ounce, is the best application in phlyctenular ulcers of the cornea; and also when serpiginous or other ulcers have nearly healed to promote the absorption of the inflammatory products, and so to lessen the amount of opacity that will be left. Good food, pure air, and healthy surroundings are most essential for patients with ulcers of the cornea. This is often shown by the rapid improvement which takes place in cases when they are admitted into a hospital, though no alteration has been made in the local applications. Tonics, cod-liver oil, one of the preparations of malt, or arsenic, or iron and quinin, should be prescribed as may seem best suited to the case.

In ulcers of the cornea which have recently perforated and through which the iris is prolapsing, the prolapsed portion should be grasped with forceps, drawn forward, and sniffed off, the cut ends being subsequently tucked back with a repositor, so as, if possible, to avoid any adhesion of the iris to the cornea. Should an ulcer have perforated and an extensive area of the cornea been destroyed, so that all possibility of regaining useful vision is destroyed, the eyeball had better be either enucleated or eviscerated.

One of these operations should also be performed if, as the result of extensive perforating ulcer of the cornea, a large unsightly anterior staphyloma has been formed.

Alterations in the Size, Shape, and Transparency of the Cornea not the Result of Inflammation.

—The cornea is a structure that varies little in size. In congenitally microphthalmic eyes it is often smaller than normal *microcornea*. As the result of increased tension in children's eyes it becomes enlarged and globular in shape, resembling very much a bullock's eye—*buphthalmos* (see Glaucoma in Children).

The most common alteration in shape of the cornea is that in which its two meridians present different degrees of curvature; it is a congenital condition, often hereditary, and gives rise to the error of refraction known as *astigmatism*, in which the rays of light falling on the eye are not all brought to a focus at the same level. The vertical meridian is the one which usually has the greatest curvature. The cornea may also be altered in shape, so that instead of presenting its usual curvatures it is dome-shaped or conical—*keratoconus;* this is due to a progressive thinning in the central portion, which gives before the intra-ocular tension. The apex of the cone is not always absolutely in the center of the cornea; it may be a little to one side or below.

The disease usually first makes its appearance about adolescence, and it occurs more frequently in females than in males. In even its earliest stages it causes considerable disturbance of vision. It can be diagnosed by the characteristic diminution which is occasioned in the size of the central portion of the corneal reflex, or by the peculiar dark ring of shadow which is seen on throwing the light into the eye with the ophthalmoscope mirror. The ring of shadow will be observed to have one part in it darker than the rest, which moves with movements of the mirror. In some cases of conical cornea the vision can be much improved with high concave cylindrical glasses. If the disease is progressive, operation is necessary. Congenital opacity of the cornea due to arrest of development is rare; it may be present in the form of an ill-defined nebula, or of a ring of opacity near the periphery—*arcus juvenilis.*

A marginal opacity of the cornea due to the deposit of colloid globules is frequently met

with in elderly people—*arcus senilis.* It commences in the form of an arc near the upper border, and afterward, in the same way, at the lower border. The two arcs may become united and form a complete circle, which is separated from the corneal margin by a zone of clear tissue.

A white band of opacity stretching transversely across the cornea a little below the center frequently forms in blind eyes—*transverse film of the cornea.* It is also met with in some cases of glaucoma, and as a rare affection in eyes otherwise perfectly healthy. It begins in two spots at the sides, a short distance from the corneal margin ; these extend inward and meet in the center, forming one band. Sometimes calcareous salts are deposited in the opaque area.

New Growths of the Cornea.—A congenital form of growth is met with at the sclerocorneal margin, which is usually of the size and appearance of a split pea. It consists of a little mass of skin, out of which hairs sometimes grow—*dermoid tumor.* They are generally located on the outer or inner margin of the cornea, a little below the center. They can be easily dissected off; but an opacity of the cornea always remains at the place where they were attached. In rare cases epithelioma and sarcoma grow from the sclerocorneal margin. In the early stages they can sometimes be completely removed from the surface of the globe; but if they have extended deeply, the whole eyeball has to be excised.

AFFECTIONS OF THE SCLEROTIC.

All inflammations of the sclerotic of which we have any definite knowledge are limited to the part anterior to the line of insertion of the recti muscles. Inflammation of the sclerotic posteriorly may possibly occur, and be one cause of myopia.

Inflammation of the sclerotic may be either superficial—*episcleritis ;* or deep—*scleritis.*

In **episcleritis** a circumscribed patch of injection and swelling is seen, which is immobile and of a dusky-red or violet hue, by which last two characteristics it is distinguished from a conjunctivitis. It may or may not be tender to the touch, and painful. There is no tendency for degeneration and ulceration to occur; and as the inflammation subsides it leaves behind a slightly depressed and discolored area. The affection is almost confined to adults, and occurs most frequently in the male sex. The subjects of it often have a gouty tendency.

Scleritis occurs not uncommonly in association with cyclitis and keratitis. In rare cases, however, inflammation seems to start as a primary affection in the interstitial substance of the sclerotic. It is a much more serious affection than episcleritis ; and the adjoining parts— uveal tract and cornea—are liable to become involved. No constitutional cause for the affection can usually be ascertained. Syphilitic gummata and tubercular nodules are sometimes met with in the sclerotic. As in episcleritis, degeneration of the inflammatory products and ulceration are unlikely to occur. On resolution setting in, the sclerotic is left much thinned, the pigment of the uveal tract shows through, and bulging sometimes takes place, a ciliary staphyloma being formed.

Treatment.—In the treatment of episcleritis the administration of sodium salicylate is often found very efficacious. Locally, massage of the eye through the lid over the inflamed area, and the application of the yellow mercuric-oxid ointment, should be prescribed.

In the deep form of infiltration atropin must be applied for the relief of pain, and on account of the tendency to iritis and cyclitis. The eye should be kept tied up, and bathed every four hours with hot boric-acid lotion. Internally, potassium iodid or small does of gray powder are most likely to be beneficial.

AFFECTIONS OF THE IRIS AND CILIARY BODY.

Iritis and Cyclitis.—Inflammation starting in any of the three anatomical divisions of the uveal tract—iris, ciliary body, or choroid—is liable to spread to one or both the others; but an inflammation of the choroid is often limited to the choroid entirely; while an inflammation beginning in either iris or ciliary body, though it generally ultimately involves both these structures, frequently does not affect the choroid. Possibly the explanation of this is to be found in the arrangement of the vascular supply. The choroid is almost entirely supplied by the short ciliary arteries; while the iris and ciliary body receive their blood from the long and anterior ciliary arteries.

As inflammation of the iris and ciliary body are so often associated, it is well to treat of them together; though the course of the disease varies somewhat according to which structure is primarily involved.

The **symptoms** and **results** of an iritis or cyclitis depend considerably on the character of the inflammatory exudate, which may be serous, plastic, or purulent. In serous iritis there is but little tendency to the formation of adhesions between the iris and lens—*posterior synechiæ;* and such as do form easily break down by the use of atropin. In plastic iritis these adhesions form early, may be of extreme density, and often yield but little to the strongest mydriatics. In some cases the whole pupillary margin of the iris becomes bound down to the lens-capsule—*complete annular synechia* or *exclusion of the pupil.* An inflammatory membrane may form, completely filling the pupil—*occlusion of the pupil.* Should the whole breadth of the iris, not only its pupillary margin, become adherent by plastic exudation to the lens-capsule, a condition of *total posterior synechia* is established.

By exclusion of the pupil, or the formation of total posterior synechia, the passage of the aqueous humor—which is secreted by the ciliary body—through the pupil into the anterior chamber becomes obstructed. When the pupil is excluded the fluid collects between the iris and lens, and the former is bowed forward, the condition being termed *iris bombé.* In total posterior synechia the fluid cannot get between the iris and lens, and collects in the vitreous chamber, the lens and iris being together pushed forward and the anterior chamber shallowed. In both conditions the tension of the eye is increased—*secondary glaucoma.* In a serous inflammation starting in the ciliary body—*i. e.,* the region in which the aqueous humor and nutrient fluid of the vitreous are secreted—an excess of fluid is poured out, which manifests itself by deepening of the anterior chamber. The aqueous humor in this condition is more albuminous than normal, and often contains a number of inflammatory cellular elements. These latter tend to collect on the lower part of the posterior surface of the cornea, where they form little dotted opacities, arranged usually in the form of a pyramid

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with its apex directed upward—*keratitis punctata.* The size of the dots varies considerably in different cases : in some they can only be distinguished on magnification ; in others they can readily be made out with the naked eye. They are usually of a grayish color, but may be pigmented. The inflammatory cells in the aqueous humor also collect in the mesh of the ligamentum pectinatum, and so obstruct the passage of fluids through the spaces of Fontana. This obstruction, the excess of fluid thrown into the eye, and its albuminous character, all tend to give rise to increase of tension, a by no means uncommon and often very troublesome complication in these cases. Inflammatory cells in serous cyclitis, besides being carried forward into the anterior chamber, are also thrown out into the vitreous humor, giving rise to opacities in it.

In an early case of serous cyclitis there are, then, the following symptoms : A variable amount of injection of the anterior ciliary vessels, often very slight ; deepening of the anterior chamber ; keratitis punctata ; and opacities in the vitreous. As the case progresses the iris may become involved and synechiæ form, or increase of tension may set in.

In *plastic iritis* a yellow exudation frequently collects in the lower part of the anterior chamber, forming an *hypopyon.*

In *purulent iritis* the course of the disease is generally very rapid ; pus accumulates in the anterior chamber ; and other parts of the eye— choroid, retina, and vitreous humor—early become involved. The case terminates, if not speedily arrested, in one of general suppurative inflammation—*suppurative panophthalmitis.* The most conspicuous symptoms of an attack of iritis are photophobia, pain in and around the eye, injection of the ciliary blood-vessels, which form a dull brick-red area around the cornea, and discoloration of the iris. If blue, it becomes altered to a greenish hue ; and if brown, to a dirty muddy brown. This alteration in color may be due to one of two causes, both of which are often present, a change in the media—cornea and aqueous humor— through which the iris is viewed, and an alteration in the iris itself, such as an increase in its vascularity or an inflammatory exudation into its tissue.

The **causes** of iritis may be classed as : 1. Traumatic. 2. Sympathetic. 3. Constitutional ; varieties of the latter being : (*a*) syphilitic, (*b*) gonorrheal arthritic, (*c*) gouty, and (*d*) tubercular.

Traumatic iritis is nearly always the result of a penetrating wound, and may vary greatly in its intensity and character. It may be so chronic as to cause scarcely any injection of the eye, and only manifest itself by the formation of one or more posterior synechiæ. A mild iritis of this sort not uncommonly occurs after operations, such as cataract-extraction. It may, however, be of a plastic, or, if septic matter be inoculated, of a suppurative, character. Plastic iritis of one eye, as the result of a perforating wound, is exceedingly likely to be followed by inflammation of a similar character in the other eye—*sympathetic iritis.*

Sympathetic ophthalmitis is an affection which is not limited to the iris : the whole uveal tract and other parts of the eye may become involved. The inflammation begins in one eye as a perforating wound

or ulcer; and is then transmitted by a path which has not been certainly determined to the other. The character of the sympathetic inflammation is sometimes serous, usually plastic, never suppurative. The *symptoms* first noticed are some haze of the vitreous, dotted opacities, either pigmented or white, on the posterior surface of the cornea, and sometimes slight optic neuritis. The patient first complains of a defect of vision.

Sympathetic inflammation may be preceded by what is termed *sympathetic irritation*, but not necessarily. Sympathetic irritation may exist for years without sympathetic inflammation coming on. Sympathetic irritation consists in certain recurrent attacks occurring in a sound eye, the fellow eye of which has been injured or has become blind through inflammation. During these attacks there are slight redness, lacrimation, and a pricking sensation or darting pain, together with fatigue of the eye on efforts of accommodation. There is often also slight disturbance of vision, compared by the patient to the appearance of a rising vapor. The eyes most liable to give rise to sympathetic irritation are shrunken blind ones, which have a new formation of bone in them on the inner surface of the choroid.

Sympathetic iritis is often very insidious in its progress, posterior synechiæ of extreme density forming gradually, and the pupil slowly becoming occluded and excluded in spite of the use of strong atropin and other remedies. The active symptoms of an attack of sympathetic ophthalmitis last generally, with varying degrees of intensity, about two years. If during that time secondary glaucoma has not been produced, the eye may then remain quiet. There are exceptional cases, however, where the inflammation is of a serous type, where the symptoms are less severe and the course much shorter.

The wounds of eyes which are most likely to cause sympathetic inflammation are those situated in the region of the ciliary body, which is therefore spoken of as the dangerous zone. Sympathetic inflammation may, however, be brought about by any wound of the eye in which the uveal tract is involved.

Inflammation has been known to occur in the sympathizing eye as early as two weeks after a wound of the exciting one; but it more frequently begins one or two months after. There appears to be no limit to the time at which a wounded eye may set up sympathetic inflammation; an interval of as much as forty years has been known to elapse.

For a long time it was held that the transmission of the disease was due to the passage of a kind of reflex nervous irritation, either along the optic nerves and optic commissure, or along the ciliary nerves. It is now more generally believed that it is due to the transmission of infection along the lymphatics of the optic-nerve sheath. The nature of the infective material is as yet undetermined.

Constitutional Iritis and Cyclitis.—Iritis and cyclitis may occur in the course of various constitutional affections; cases are also met with in which the closest examination can elicit no constitutional cause.

(*a*) Syphilis is the constitutional disease which most frequently gives rise to iritis and cyclitis. The typical syphilitic iritis occurs during the secondary stage of the disease, from the second to the eighth month after infection. In it little nodules of a yellowish or rusty brown color are generally seen at the pupillary margin or periphery of the iris. It is a form of inflammation that rarely recurs. Iritis, not nodular, but due probably to the syphilitic

poison, is met with in the later stages of syphilis ; also in infants and children the subjects of inherited syphilis, both with and without interstitial keratitis.

True gummata are met with in the late stages of syphilis both in the iris and ciliary body ; they form gray or yellow masses, which can only be diagnosed from tubercular nodules or leukosarcoma by the history of the cases and the effects of treatment.

(*b*) Gonorrheal iritis occurs in cases where gonorrhea has given rise to arthritis ; the inflammation of the iris resembles that of the joints in its serous character and its marked tendency to relapse. Fresh attacks may set in many years after the original infection. It is, indeed, the most relapsing of any form of iritis. It has generally been described as rheumatic iritis, but is not so termed here, as it is not met with in connection with acute articular rheumatism.

(*c*) Gout, both acquired and hereditary, may give rise to iritis and cyclitis of a relapsing character, often very chronic and insidious in its onset.

(*d*) Tubercle affects the iris and ciliary body either in the form of scattered miliary nodules or of larger caseating masses. As already mentioned, these latter are liable to be confused with syphilitic gummata or leukosarcomata.

Treatment of Iritis and Cyclitis.—In the local treatment of iritis the first point is to get the pupil well dilated ; and the ease with which this can be done will depend on the duration of the case and the serous or plastic character of the affection.

A 1 per cent. ointment of atropin made up with vaselin should be put into the eye every two hours on the day the patient first presents himself. If, after that, all synechiæ have been broken through, the dilatation should be maintained by applying the ointment three times a day until the injection of the eye has quite subsided.

The pain and photophobia will in some cases be greatly relieved after one or two applications of the atropin. An eye with iritis or cyclitis should be fomented with hot boric-acid lotion, 2 per cent., every four hours, and in the intervals kept tied up with a compress of cotton-wool.

Should the pain persist after the application of these remedies, it may be almost certainly relieved by the withdrawal of a small quantity of blood from the temple by the application of two leeches or by a Heurteloup artificial leech.

In certain patients atropin causes violent inflammation of the skin of the lids and conjunctiva, which may even spread to a large part of the face, and give rise to considerable swelling and redness, resembling an attack of erysipelas, for which sometimes it has been mistaken. In such cases one of the other mydriatics—hyoscin, duboisin, or daturin— must be substituted for the atropin.

In cases of serous iritis or cyclitis where the tension is increased, it might be imagined that atropin was contra-indicated ; but this is not so. The angle of the anterior chamber in these cases is not obstructed by the root of the iris, but is more widely open than normal, so there is no fear of increasing obstruction to the exit of fluid by the thickening of the iris when the pupil is dilated. By its use the tendency to the formation of posterior synechiæ is prevented. In these cases the increased tension must be relieved by paracentesis of the anterior chamber, repeated as often as may be found necessary.

In some cases of iritis the most vigorous use of atropin fails to break down all the adhesions that have formed. Should a complete annular synechia remain and the iris have become *bombé*, it will be necessary to perform an iridectomy to relieve the secondary glaucoma which is set up. An iridectomy for this condition is usually a satis-

factory procedure, for though the recently inflamed iris may be thickened and very friable, a very small opening made in it is sufficient to re-establish the circulation of the intra-ocular fluids.

Besides the local treatment, the constitutional cause of the affection must, if possible, be discovered and appropriate remedies be prescribed. In the syphilitic forms the patient should be got rapidly under the influence of mercury, applied either in the form of inunction, or of gray powder administered internally in 2-grain doses three times a day.

In the gouty forms a mixture with 5 or 10 grains of potassium iodid is most beneficial. In the gonorrheal cases the patients are often much debilitated, and a tonic containing iron and quinin is the best medicine to administer internally.

The local treatment of sympathetic ophthalmitis is much the same as that of other forms of iritis and cyclitis. In some of the worst cases the pupil becomes gradually contracted and the iris bound down in spite of the most energetic application of mydriatics.

Operative interference in an eye with sympathetic ophthalmitis should be postponed, when possible, until all active inflammation has subsided. Occasionally, when secondary glaucoma sets in, this is not possible, and an iridectomy has to be performed.

Disturbances in the Muscles of the Iris and Ciliary Body.—Disturbances in the mobility of the iris manifest themselves by alterations in the condition of the pupil.

The pupil, apart from alterations due to the presence of synechiæ, may be abnormally large—*mydriasis;* or abnormally small—*myosis.* The pupils of the two eyes may be unequal in size—*anisocoria.* A pupil may be inactive to both light and accommodation, or inactive to light while it retains its power of action on accommodation—*Argyll-Robertson's pupil.*

In some conditions, when light is thrown on the eye, the pupil is observed to oscillate to an abnormal extent; *i. e.,* for a short while to keep on contracting and dilating—*hippus.*

Disturbances in the ciliary muscle manifest themselves by alterations in the power of accommodation and in the refraction of the eye. It may be paralyzed—*cycloplegia*—or spasmodically contracted.

Congenital Abnormalities of the Iris.—A portion or the whole of the iris may be congenitally absent. When only a portion is absent—*coloboma*—it is generally a sector in the lower half, most frequently in the lower and inner part. Coloboma of the iris is often associated with a congenital deficiency in the choroid or ciliary body, and sometimes also a notch in the lens.

Apparent complete absence of the iris—*aniridia*—is a rare form of malformation. It is not uncommonly hereditary.

On dissection a narrow rim of iris hid behind the extreme periphery of the cornea is found in the majority of cases.

Displacement of the pupil from the center of the iris—*ectopia pupillæ*—of a slight extent is not uncommon. Very extensive displacement of the pupil in different directions sometimes occurs. It is often combined with congenital displacement of the lens. In fetal life the fibrovascular membrane which covers the anterior surface of the lens, as the iris grows in beneath it, becomes converted into a pupillary membrane, which disappears before birth. In some cases strands of this membrane remain—*persistent pupillary membrane.* It is important to distinguish these fibers when attached to the lens-capsule—*capsulopupillary membrane*—from posterior synechiæ the result of inflammation. The congenital defect can always be diagnosed by the fact that the tags proceed from the anterior surface of the iris, usually from one of the projections at the small circle.

AFFECTIONS OF THE CHOROID.

Choroiditis.—Inflammation of the choroid may be suppurative or non-suppurative. Suppurative inflammation occurs generally as the result of perforating wounds; it may also be pyemic. The inflammation tends to spread rapidly to surrounding structures—the retina, vitreous,

ciliary body, and iris; so that the condition soon becomes one of suppurative panophthalmitis. The conjunctival and ciliary vessels are then much injected, and perforation ultimately occurs. In these cases the sight will certainly be destroyed, and the eyeball should be enucleated or eviscerated early for the relief of pain.

In non-suppurative inflammation of the choroid the exudation is generally found scattered throughout the membrane in small patches—*disseminated choroiditis;* sometimes these patches become united and form large areas. Occasionally the affection is localized in one part—*circumscribed choroiditis.* When so localized the macula-region is very frequently the part affected—*central choroiditis.*

In the exudative stage of choroiditis the ophthalmoscopical appearances consist in the presence of a patch or patches of a yellowish color, situated beneath the retinal vessels, whose margins shade off gradually into the surrounding red reflex, which in their immediate vicinity is more than usually intense.

When cicatricial changes have set in, the blood-vessels in the affected area to a greater or less extent become destroyed, so that the large deep vessels of the choroid or the white sclerotic become exposed to view. The pigment-epithelium at the margin of the patches, by proliferation, becomes heaped up, growing into the retina and forming irregular black rings around them.

In cases where the retina is involved, opacities frequently form in the vitreous which may remain permanently.

If there is much plastic exudation in a choroiditis a new formation of bone sometimes takes place on its inner surface. This usually occurs when there has also been extensive iridocyclitis and when the eyeball has become shrunken—*phthisis bulbi.*

Syphilitic Choroiditis.—Choroiditis occurs in both inherited and acquired syphilis, commencing usually from one to three years after infection.

The inflammation is of the disseminated variety, affecting chiefly the peripheral parts. Both eyes are usually involved, not necessarily to the same degree; sometimes only one is attacked.

In certain cases the pigmentation of the retina is very extensive in the peripheral parts, and there is contraction of the field of vision, with night-blindness. Such cases are very liable to be confused with retinitis pigmentosa.

The presence in it of punched-out-like circular areas of choroidal atrophy generally serves, however, to distinguish it from that affection.

Treatment of syphilitic choroiditis is most likely to prove beneficial when the disease is in its exudative stage. Then the administration of mercury and potassium iodid tends rapidly to promote the absorption of the inflammatory products.

In the later stages, where cicatrization has taken place, no improvement can be hoped for; but whenever the deterioration of vision is progressive antisyphilitic remedies should be persevered with.

Tubercular Choroiditis.—Tubercle of the choroid may, like that of the iris and ciliary body, occur in the form of scattered miliary nodules, or as large aggregate masses which break down and undergo caseation.

The former are most frequently met with in cases of tubercular meningitis, and can be seen ophthalmoscopically as circular grayish patches; they do not generally cause any very marked disturbance of vision.

The larger masses of tubercle give rise to symptoms which may be indistinguishable from those of glioma of the retina.

Atrophy of the Choroid.—In myopia, as the result of elongation of the eyeball, the choroid frequently becomes stretched and atrophied. The most marked change takes place at the outer margin of the optic disk, where the sclerotic bulges out, forming a posterior staphyloma. Ophthalmoscopically, in a slight case a white crescentic area is seen at the outer margin of the optic disk in which the sclerotic is exposed to view—*myopic crescent.*

In high degrees of myopia the white atrophic area may be found surrounding the whole disk. In progressive cases patches of bright-red, congested choroid are often seen at the margins of the atrophied area. Separate patches of atrophy, in which the sclerotic becomes exposed, also form sometimes in the macular region, destroying central vision.

Hemorrhage from the Choroid.—Hemorrhage from the choroid varies in extent. Slight hemorrhages are most frequently seen after blows on the eye with blunt objects. They are usually circular in shape, of a duller red color than retinal hemorrhages, and are situated beneath the retinal vessels, which can be seen to be quite normal in appearance. Sometimes gray striation of the retina can be distinguished in front of the patches. As the hemorrhages are absorbed a patch of sclerotic is exposed through the rupture in the choroid which gave rise to the hemorrhage.

Extensive hemorrhages from the choroid occasionally occur in connection with perforating wounds, or operations, such as extraction of cataract or iridectomy for glaucoma. In such cases the contents of the globe are forced out through the opening, and the choroid widely separated from the sclerotic.

Sarcoma of the Choroid.—Sarcoma of the choroid is usually melanotic, but may be perfectly white; the shape of the cells may be round or fusiform. It may occur at any age, but is most frequently met with between forty and fifty. At first it gives rise to detachment of the retina; later, to increased tension and all the symptoms of glaucoma. If it passes out of the globe, it usually does so along the track of one of the blood-vessels which perforate the sclerotic, and develops rapidly into an extensive growth in the orbit. Secondary growths may occur in almost any part of

FIG. 417.—Portion of an eyeball containing a sarcoma growing from the choroid in a pedunculated manner. Retina detached from the choroid, but adherent to the apex of the growth.

the body, and they are frequently met with in the viscera, especially the liver.

An eye should be excised as soon as sarcoma of the choroid has been diagnosed. The earlier the sarcoma is removed the less risk there is of recurrences or the formation of secondary growths.

Congenital Abnormalities of the Choroid.—The commonest form of congenital abnormality met with in the choroid is *coloboma*.

The sclerotic and choroid are developed from mesoblastic tissue which surrounds the secondary optic vesicle; when blood-vessels form in the inner part, which is to become choroid, it is differentiated from the sclerotic. Sometimes the inner portion of the enveloping mesoblast fails to become vascularized, and then no choroid is developed in that position.

On looking into an eye with such a defect, with the ophthalmoscope, a white area with sharply defined margins is seen, sometimes a little depressed below the level of the rest of the fundus. The most frequent locality in which this defect in the choroid is met with is in the region of the ocular cleft—*i. e.*, at the lower part of the fundus. It may, however, occur in other positions.

AFFECTIONS OF THE CRYSTALLINE LENS.

The most common morbid change in the lens is an alteration in its transparency. There is no such thing as an inflammation starting primarily in the lens; whenever leukocytes invade its substance from neighboring parts, there is always first a destruction of the lens-capsule.

Cataract.—A lens having an opacity is said to be cataractous. Opacities of the lens are always due to some disturbance of its nutrition, which may be the result of general or local disease.

The form, situation, and extent of opacities in the lens vary considerably. A cataract is *mature* when the whole lens appears opaque, the opacity extending up to the posterior surface of the iris. So long as clear lens-matter intervenes between the opacity and the iris a dark shadow is cast by the latter on the surface of the opacity, visible at the pupillary margin. When, therefore, this dark shadow is absent, we know that all the cortical substance has become opaque.

When a lens has first become completely opaque, the radial markings on its surface are clearly visible. In course of time, if nothing is done, these markings disappear, and the surface of the cataract presents a uniform bluish-gray appearance. The cataract is then spoken of as *hypermature*. The cortical substance gradually undergoes disintegration and liquefies, so that the solid nucleus ultimately comes to float in a bag of opaque turbid fluid.

Incomplete or partial opacities of the lens may be located and arranged in the following different ways:

1. The nucleus alone opaque—*nuclear cataract.*

2. A layer or zone of lens-substance, more or less opaque, surrounding the nucleus, the nucleus and cortex remaining clear—*zonular or lamellar cataract.*

3. An area of opacity at the anterior pole of the lens—*anterior polar cataract.* Sometimes the anterior polar opacity is raised as a conical projection above the surrounding surface of the lens—*pyramidal cataract.*

4. A point of opacity at the posterior pole of the lens, with radiating bands running out from it—*posterior polar cataract.*

5. Numerous scattered dots of opacity, chiefly situated in the peripheral parts—*dotted cataract.*

6. Gray striæ in the cortex, or white flakes, or irregular nebulæ.

Cataracts may be classified as follows: Congenital, infantile, senile, diabetic, and local.

Congenital Cataracts.—The lens is nourished during fetal life, previous to the establishment of the secretory function of the ciliary body and formation of the anterior chamber, by a fibrovascular sheath which surrounds it. The vessels of this sheath are derived from the anterior ciliary arteries and the central artery of the vitreous. Disturbances in the nutrition of the lens during fetal life, and consequent opacities, may arise from either faulty developments of the fibrovascular sheath, its abnormal persistence, or delay in the formation of the anterior chamber, causing prolonged contact of lens and cornea.

A congenital opacity of the lens may be complete or partial. Complete congenital cataracts vary in consistency, sometimes being thin and

watery, at other times jelly-like in character. In a third class of cases the lens is not only opaque, but considerably shrunken, forming a thick, dense membrane, which it is very difficult to tear through with needles.

Partial congenital opacities may be situated at the anterior or posterior pole of the lens, or arranged as a series of dots round the periphery of the lens. This latter form is often met with in several members of the same family.

Infantile Cataracts.—It is sometimes impossible to decide whether an opacity of the lens has commenced previous to birth or in early infancy. Most anterior polar cataracts are certainly infantile, occurring in connection with affections of the cornea in ophthalmia neonatorum.

In infancy the anterior chamber is exceedingly shallow, and any thickening of the cornea, the result of inflammation in it, readily brings its posterior surface into contact with the anterior pole of the lens. As the result of such contact opacities of the lens develop, owing mainly to proliferation of the cells lining the capsule. Cases are frequently met with having nebulæ of the cornea and anterior polar opacities of the lens, concerning which, on inquiry, a history of ophthalmia neonatorum is obtained.

Zonular cataracts are most often infantile in origin, and are always bilateral. They occur in children who suffer from fits, and in whom the enamel of some of the permanent teeth, most frequently the first molars and the incisors, develops in an irregular way, so that it presents a worm-eaten or honeycombed appearance. It is probable that they are due to some malnutrition in early infancy from improper feeding. Some cases presenting this form of cataract are certainly the subjects of rickets.

Senile Cataracts.—In senile cataracts the opacity usually begins in the cortex around the nucleus, either in the form of peripheral striæ or a central nebula. It tends to spread, with very varying degrees of rapidity, until the whole cortex becomes involved. The precise cause of senile cataract so far remains undetermined. Though a frequent accompaniment, it is by no means a necessary complication, of old age, and must be regarded as a diseased, and not a physiological, condition. It may commence during the fifth decade of life; but is most common during the sixth. It nearly always affects both eyes; though the opacity in one lens is usually found to have commenced sooner, and to be more advanced, than in the other.

Diabetic Cataracts.—When cataract occurs as the result of diabetes both eyes are affected, usually at the same time. The opacity extends rapidly. In a few exceptional cases, in which the general condition of the patient markedly improves, the opacity has been observed to disappear, the lens regaining its normal transparency. The formation of the opacity is not due to the presence of sugar in the lens, but appears to be associated with an increased specific gravity of the blood.

Cataracts Due to Local Causes.—Cataracts may be formed as the result of certain diseases of the eye in which there is interference with the surrounding vascular supply from which the lens receives its nutriment. These diseases are iridocyclitis, high degrees of myopia, retinitis pigmentosa, choroiditis, detachment of retina, and prolonged glaucoma.

Treatment of Cataract.—The only cases in which a cataractous lens has had its normal transparency restored are a few exceptional ones, already referred to, occurring in connection with diabetes. When the opacity is confined to the center of the lens, the vision may sometimes be improved for a while by keeping the pupil dilated with a solution of atropin sulphate, 1 : 1000, applied twice a week. It may, however, be taken as a general rule that when a lens has become so opaque as to interfere with useful vision, the only remedy consists in its removal and the wearing of suitable glasses. The removal of the lens may be accomplished by the operation of discission or by that of extraction. The former is the more suitable for young people, when the nucleus of the lens is small and soft; and the latter for old people, when the nucleus is large and hard.

It is a matter of considerable importance to determine when an operation for cataract is advisable. No hard-and-fast rule can be laid down as suitable for every case. It is preferable to operate on a senile cataract when it is complete. If there is any transparent cortex, it is impossible to be sure that it is all removed at the time of the operation, because it cannot be seen. The pupil may appear clear and black at the conclusion of the operation; but when examined a few days later, it will be seen filled with lens-matter which has become opaque afterward. On the other hand, if the patient is incapacitated from following his occupation on account of his sight, and the cataracts are incomplete, it is better to operate at once, as no limit can be fixed to the time which they may take to become complete. Even if some cortical matter is left, which becomes opaque afterward, it can always be dealt with by a subsequent needle-operation.

If a patient has a cataract in one eye and no sign of opacity in the lens in the other, it is only under special circumstances that operation is advisable. If the lens is removed from one eye and not from the other, the two eyes can never be kept accurately adjusted for the same focus—binocular vision is impossible. Most patients object to wearing glasses when they see perfectly with one eye without them, more especially when the glass for the defective eye gives accurate vision at only one distance. In some occupations the enlargement of the field of vision which the removal of the lens affords, even though there is not accurate vision, is of importance, as, for instance, in coachmen. In such cases, and also should the cataract be very white and unsightly, it may be necessary to remove it even though the lens of the other eye shows no changes.

If a patient has a complete cataract in one eye and opacities in the other lens, provided his or her expectancy of life is good, it is advisable to remove the cataract while mature, rather than let it become hypermature; for then thickenings and chalky deposits are liable to form in the capsule, which may be difficult to deal with.

Diabetic patients are less favorable subjects for operation than other people; they are liable to a chronic form of iritis; and sometimes the shock of the operation gives rise to a fatal attack of coma.

No limit can be fixed to the age at which the operation of extraction may be successfully performed; it has been done on centenarians. Not every case of lamellar cataract requires operation; in some the zone is

of so little density that very useful vision is obtained through it. Even should the acuity of vision be considerably less than normal, it is better for the patient to endure the defect and retain the power of accommodation than to be obliged constantly to wear glasses of different strengths for distance and for near work. If a patient with lamellar cataract can see $\frac{6}{18}$, it is certainly not desirable to operate.

It is often difficult to determine the most favorable age at which to operate on a patient with congenital cataracts. In infants the anterior chamber is very shallow and there is not much aqueous humor; the pupil, moreover, in patients with congenital cataract often does not dilate well with atropin, so that the conditions in infancy are not very favorable for operation. On the other hand, the first two years of life are the most important in what may be termed the education of the retina and development of the visual centers. If operation is long delayed, nystagmus is sure to develop. The end of the first year will, as a rule, be found the most suitable time for operation.

Congenital Malformation of the Lens.—Displacement of the lens—*ectopia lentis*—is sometimes met with as a congenital malformation, and is due to a defect in the development of the suspensory ligament. The direction of the displacement is nearly always upward with, some inclination either inward or outward; that is to say, it is usually displaced away from the ocular cleft.

The displacement may be so extreme that the patient obtains good vision with a glass of about 10 diopters through the aphakic area. More often, however, vision is much impaired by the irregular refraction caused by looking through the lower half only of the lens; this may to some extent be remedied by the use of concave glasses.

A notch in the border of the lens—*coloboma lentis*—is a rare form of malformation sometimes met with in connection with coloboma of the iris and ciliary body.

AFFECTIONS OF THE VITREOUS HUMOR.

The vitreous humor is an avascular structure which receives its nutrient fluid by secretion from the ciliary body. It cannot, therefore, be the seat of a primary inflammation, but may have inflammatory products discharged into it in the course of a cyclitis or retinitis. Hemorrhage may occur into it from the retinal or ciliary vessels, and it may be the seat of degenerative changes or of congenital malformations.

Invasion of the Vitreous Humor by Inflammatory Products.—The inflammatory exudation which is thrown into the vitreous in a cyclitis or retinitis may be purulent, plastic, or catarrhal in character.

When pus collects in the vitreous it is part of a general suppurative inflammation of the whole eyeball—*panophthalmitis*—and ultimately ends in perforation of the globe. It is the result of septic wounds or pyemia.

A plastic exudation thrown out into the vitreous may organize into fibrous tissue in which blood-vessels develop, continuous with either those of the ciliary body or retina.

The plastic exudation in the process of organization has great tendency to contract, and so to displace surrounding structures. If adherent to the retina, it detaches it from the choroid. If a band stretches across the ciliary region—a *cyclitic membrane*—it draws the ciliary body away from the sclerotic and tends to push forward the lens, shallowing the anterior chamber in the center. If the plastic exudation extends forward into the circumlental space and becomes adherent to the root of the iris, it will, in organizing, retract the root of the iris and deepen the periphery of the anterior chamber.

When fibrous membranes form in this way in the vitreous humor and the lens remains clear a yellow or grayish reflex is seen through the pupil, and sometimes newly formed blood-vessels are visible.

A yellowish-gray reflex behind the lens with blood-vessels on its surface are the symptoms presented by glioma of the retina; frequently there is great difficulty in diagnosing between true glioma and these inflammatory membranes in the vitreous—*pseudoglioma*.

The chief points to which attention should be directed, to arrive at a diagnosis, are the history of the case and the condition of the anterior chamber. The inflammatory affections usually follow some acute illness—measles, scarlet fever, or an attack in which there has been reason to suspect meningitis.

In true glioma the anterior chamber is never deepened at the periphery and shallowed only in the center, as is frequently the case in pseudoglioma.

When the inflammatory exudation into the vitreous is of a serous or catarrhal character a general haze or numerous fine, dust-like opacities are first seen. Later on the general haze clears up, but varying-sized, irregular-shaped opacities, or webs of opacity, may be left, which, owing to the consistency of the vitreous having become abnormally fluid, tend to float up and down.

In myopic eyes, and sometimes as the result of a senile change, the vitreous humor becomes shrunken, undergoing degeneration and liquefaction—*synchysis.* Floating opacities then make their appearance in the vitreous chamber, of the annoyance caused by which patients often complain considerably. In some rare cases cholesterin crystals are met with in the vitreous, and give rise to opacities, which, when viewed with the ophthalmoscope mirror, are bright and glistening—*sparkling synchysis.*

The majority of people are able to see opacities in their vitreous on looking fixedly at a white surface—*muscæ volitantes.* The sudden discovery of these is to some people very alarming. They have a branch-beaded shape, and are due to the persistence of portions of a structural network which extends throughout the vitreous in the fetal eye.

Hemorrhage into the Vitreous.

Hemorrhage into the Vitreous.—Hemorrhage into the vitreous may occur from blows on the eye or as the result of violent expiratory efforts, such as straining at stool or vomiting. In some young men recurrent hemorrhage into the vitreous occurs apparently spontaneously. Such patients are also liable to attacks of bleeding from the nose, and in most a decided gouty tendency can be traced.

If a hemorrhage into the vitreous has been extensive, nothing but a dark reflex is obtained on throwing light into the eye with the ophthalmoscope; in most of the cases, on oblique illumination dark-red clots can be distinguished behind the lens. Where only a small hemorrhage has occurred, blood-clots can be seen in the vitreous with the ophthalmoscope.

Blood in the vitreous may become absorbed, leaving only a few floating opacities behind; or the clots may become the matrix for the formation of bands of fibrous tissue, in which blood-vessels continuous with the retinal vessels develop. These bands of newly formed fibrous tissue can be seen, ophthalmoscopically, presenting very irregular outlines. Sometimes, by their contraction, they bring about detachment of the retina. The treatment of a case of hemorrhage into the vitreous will depend to a great extent on the cause. Any tendency to constipation should be remedied by the use of saline purgatives. All stooping and straining efforts should be avoided. Potassium iodid, in 5-grain doses three times a day, should be prescribed, partly on account of the gouty tendency and partly to promote absorption of the blood-clots. In cases in which the hemorrhages are recurrent, ½-dram doses of the liquid extract of ergot have been recommended.

GLAUCOMA.

The term glaucoma was originally applied to affections of the eye in which a greenish reflex was observed in the pupil. The meaning of the word as now used is best defined as " an excess of pressure within the eye plus the causes and consequences of that excess " (Priestley Smith).

When the increase of tension in the eye occurs without any obvious antecedent disease, the glaucoma is said to be *primary ;* and when definite disease of the eye has preceded it, *secondary.*

The affections which may give rise to secondary glaucoma have

been described under their respective headings. It is therefore only necessary to enumerate them here. They are serous iritis and cyclitis; annular posterior synechiæ; anterior synechiæ of iris, after either perforating wounds or perforating ulcers; anterior synechiæ of the lens-capsule (which is one of the commonest causes of the increased tension that occurs after extraction of cataract); wounds of the lens; dislocation of the lens, either into the anterior chamber or laterally; intra-ocular tumors; intra-ocular hemorrhage.

Primary glaucoma may commence in different ways and run a variety of courses. It may set in with acute suddenness, with intense pain in both head and eye, rapid loss of sight, and violent vomiting. On the other hand, it may make its appearance very gradually, so that the patient is unable to fix the date of the onset of the disease, the only manifestation of which he is acquainted with being a slow failure of sight. Many degrees of acuteness between these two extreme classes of cases are met with. It is very common in the course of a chronic attack for exacerbation of symptoms to occur from time to time, leaving when they pass off greater permanent impairment of vision than was present previous to their onset.

During these attacks of exacerbation there is an increased dimness of vision, the patient describing it as appearing like a fog in front of his eye; he also sees around lights circles of colors like those of a rainbow, and complains of a variable amount of pain.

Occasionally an attack of intense acuteness will supervene in an eye which has been the seat of chronic glaucoma for some time.

Certain causes which seem specially liable to excite acute attacks in those who are predisposed to glaucoma are, mental anxiety, such as ensues from the death of a near relative or from business losses; want of sleep; neuralgic attacks; exposure to cold; constipation; and straining of the eyes with unsuitable glasses. If we exclude the variety of glaucoma which occurs in infancy, which is due to some congenital defect in development and which will be dealt with later, primary glaucoma previous to the age of thirty-five may be said to be an exceedingly rare affection; from that age on to sixty the tendency to it gradually increases.

Primary glaucoma is more common in hypermetropes than in myopes or emmetropes. Eyes are predisposed to it in which the cornea is abnormally small. Females are more liable to glaucoma than males, especially its acute forms.

The amount of tension in an eye is best determined for clinical purposes by estimating the degree of resistance of its tunics. This is done by first directing the patient to look downward, then placing the index finger of each hand on the upper eyelid and making pressure alternately first with one and then with the other. It is always well to make a comparison of the tension of the two eyes.

When the tension of the eye is normal, it is described as T. n.

When there is a slight but decided increase in the normal tension, as T. + 1.

When the increase is more marked, but the fingers can still slightly impress the globe, as T. + 2.

When the increase is so marked that no dimple whatever can be made, as T. + 3.

In cases where there is difficulty in determining the exact degree of resistance, a note of interrogation is added, thus T. + 1?

In the same way, when the tension is diminished, three different degrees are recognized and recorded respectively as T. — 1, T. — 2, and T. — 3.

The **symptoms** of glaucoma, their causation and significance, will be best described by considering the effects of increased tension on the intra-ocular blood-vessels and nerves.

Increased tension of the eye causes obstruction to the circulation in the uveal tract, and consequent congestion of the anterior ciliary blood-vessels on the surface of the globe.

In acute cases the congestion of both arteries and veins is intense, and has led to this form of glaucoma being spoken of as inflammatory.

In subacute cases enlarged episcleral veins are frequently seen, while in the most chronic cases there may be no congestion at all.

The obstructed ciliary circulation brings about slight changes in the surface epithelium of the cornea, which renders it hazy and less lustrous than normal. This haziness is particularly marked during the temporary exacerbations of the disease which occur in some cases. When the tension of the eye is diminished, as by operation, it rapidly disappears.

In cases of glaucoma of long standing a more marked haze of the cornea makes its appearance, due to an edematous condition of its anterior layers.

It is the early, slight, often transient attacks of haze of the cornea which give rise to the symptoms of colored rings around lights, already referred to.

The effects of increased tension on the retinal blood-vessels is to obstruct the entrance of blood by the arteries and its exit by the veins, so that their relative size is altered, the veins being distended and large, the arteries imperfectly filled and small. The arteries, especially the main trunks near the disk, are seen to pulsate, which is an important symptom in the diagnosis of early doubtful cases of glaucoma.

The imperfect filling of the retinal blood-vessels causes the nutrition of the retina to suffer; this first manifests itself where the vessels are smallest—*i. e.*, in the peripheral parts—and is recognized clinically as a contraction in the field of vision. As the vessels which supply the temporal half of the retina have to run a longer course than those going to other parts, the outer part of the retina is the first affected, and the contraction of the field commences on the nasal side. The pressure of the ciliary nerves against the hard, unyielding sclerotic, as they course forward on the outer surface of the choroid, is the cause of the intense pain in acute cases of glaucoma. So much do these nerves become compressed, that often their conducting power for both sensory and motor impulses becomes abolished. Hence we commonly find in glaucoma that when the tension is high the cornea is insensitive, the pupil dilated and inactive, and the power of accommodation defective.

A defect in the power of accommodation is often one of the earliest symptoms noticed by patients with glaucoma. They come complaining of having to keep on increasing the strength of their glasses for near work.

The effects of increased tension on the optic nerves are most marked. The position where it enters the eyeball, across which the lamina cribrosa stretches, is the weakest spot in the walls of the globe. Hence

when the tension is raised it readily becomes depressed backward, and the nerve-fibers atrophy from compression against the edge of the unyielding sclerotic.

The ophthalmoscopic appearances to which these changes give rise are gradual alterations in the color of the optic disk to a bluish-white, and cupping of it, slight in the early stages, but increasing as the disease advances. The characteristics of a glaucomatous cup which serve to distinguish it from a physiological one, or one due to simple atrophy, are as follows:

The cup involves the whole surface of the disk, not only a portion, as in the physiological condition. There is a typical bending of the vessels, so that those on the disk do not seem directly continuous with those on the retina, the intervening portion having become lost from view, due either to their passage vertically forward along the sides of the cup, or to their following the curve of some lateral excavation in it.

A symptom of glaucoma frequently present, and not as yet referred to, is shallowness of the anterior chamber. It is one which often precedes the increase of tension, so that eyes with shallow anterior chambers are said to be predisposed to glaucoma.

All eyes which have had primary glaucoma, when examined pathologically, are found to have the angle of the anterior chamber closed by the apposition of the root of the iris to the posterior surface of the cornea, so that the exit of the aqueous humor from the eye in that position is obstructed. It is probable, however, that the primary obstruction to the circulation is farther back at the circumlental space, because the vitreous chamber is the one which becomes distended, the lens and the iris being displaced forward.

Obstructions at the circumlental space and pressure forward of the root of the iris are both favored by congestion and swelling of the ciliary processes, and it seems probable that the onset of attacks of glaucoma are brought about in that way.

Glaucoma in Children's Eyes; Buphthalmos.—Increased tension of the globe when it occurs in children, owing to the elasticity of the cornea and sclerotic in early life, produces symptoms very different from those produced in adults. The whole eyeball becomes enlarged, the cornea often out of proportion to the rest, so that the appearance produced simulates that of a bullock's eye; hence the term buphthalmos.

As the result of the enlargement, all the tunics of the globe become stretched and atrophied, the sclerotic being so thinned that the pigment of the uveal tract shows through it. As the tissue stretches before the increased tension, the ciliary nerves do not become pressed upon in the same way as they do in the adult; consequently, glaucoma in a child's eye is not usually a painful affection. Glaucoma in a child's eye, as in the adult, may be secondary to various other diseases, such as perforating ulcer and anterior synechiæ, closed pupil from iritis or intra-ocular growth.

There is also a form of glaucoma in children which dates from birth, and which is due to some congenital defect in the angle of the anterior chamber which obstructs the exit of fluids there from the eye. In these cases the anterior chamber is usually deep, the iris is much atrophied, and the optic disk deeply cupped. It is an affection which may progress to blindness or undergo a spontaneous arrest.

Treatment of Glaucoma.—Permanent cure of primary glaucoma can only be brought about by operation. Eserin applied to the eye will in many cases reduce the tension and relieve the symptoms; but the patient is always liable to a recurrence if the use of the drug is subsequently discontinued.

Though numerous different operations have been suggested for

glaucoma, iridectomy, or, rather, iridectomy-dialysis (see page 834), is the most effectual.

The cases in which the best results are obtained by operation are the acute ones, or chronic ones of recent origin. In cases of long duration, firm adhesions of the root of the iris to the cornea in the filtration-area occurs, and their separation cannot be effected.

The best guide as to the prospects of success in operations for glaucoma is the degree to which the pupil contracts under the influence of eserin.

In cases of glaucoma with hemorrhages in the retina, and in some chronic cases in elderly individuals, it is advisable to keep the eye permanently under eserin rather than operate. Eserin has a tendency to cause dilatation of the ciliary blood-vessels; hence, in using it for glaucoma, it is well to combine it with cocain, which has, by stimulation of the sympathetic, the opposite effect of contracting the ciliary vessels.

Drops containing $\frac{1}{6}$ part of eserin sulphate, 1 part of cocain hydrochlorate, to 100 parts of water, keep the pupil contracted and do not produce ciliary injection. In children's eyes, operations for the relief of tension do not usually prove satisfactory. If, however, in spite of the use of eserin, the disease continues to progress, an iridectomy or a sclerotomy should be performed.

AFFECTIONS OF THE RETINA.

Retinitis.—Inflammation of the retina may be diffuse or circumscribed; the optic papilla is frequently involved. When the inflammation is diffuse there is a general haze of the normally transparent retina as the result of exudation into it; there is often also some exudation into the vitreous humor, manifesting itself as floating opacities. Many forms of inflammation of the retina are accompanied by hemorrhages. It is exceedingly difficult in some cases to determine whether the hemorrhages are the result of inflammation or primary.

Inflammatory products may become absorbed, leaving behind little or no permanent defect; on the other hand, atrophy may ensue, with destruction of the nerve-elements and increase of the fibrous tissue. This is often accompanied by overgrowth of the pigment-epithelium and the formation of areas of pigmentation in the retina.

In some cases opaque white patches are seen in the retina; these vary in size, depth of color, appearance of their margins, and position.

White lines and punctate spots with sharply defined edges arranged in the form of an asterisk around the yellow spot, together with larger, soft-edged, light-colored patches around the optic disk, are the typical changes seen in **albuminuric retinitis.** A nearly complete broad band of dense white opacity may surround the yellow-spot region— **retinitis circinata.** Numerous small white dots may be disseminated all over the fundus—**retinitis punctata albescens.**

Syphilitic Retinitis.—Syphilitic retinitis is most frequently secondary to choroiditis, but may occur primarily as a diffuse affection, usually late in the secondary stage of the disease.

Besides the diffuse haziness of the retina, there is usually enlargement of the retinal veins, and fine, dust-like opacities in the vitreous. Hemorrhages and white spots are not often seen. The vision during the active stage is much affected, but usually improves greatly when the inflammation subsides under treatment.

Albuminuric Retinitis.—Retinitis may occur in all forms of albuminuria, but is most frequently met with in connection with contracted granular kidneys. Its occurrence in connection with kidney disease is an unfavorable symptom, patients rarely living longer than a year after it has made its appearance. In cases of albuminuria associated with pregnancy, in which retinitis not uncommonly occurs, when the patient recovers from the albuminuria the retinal changes may entirely disappear and normal vision be restored. On the other hand, the disturbance may have been so extensive that permanent defect of vision remains. The optic nerve sometimes becomes atrophied. Besides the white spots mentioned above as characteristic of albuminuric retinitis, hemorrhages are also frequently met with. These hemorrhages have a striated or "flame-shaped" appearance. The blood-vessels also are generally enlarged. The changes are nearly always bilateral.

Diabetic Retinitis.—Occasionally retinitis is met with in connection with diabetes quite unassociated with nephritis. The changes seen consist of white patches of hemorrhages very similar to those met with in albuminuric retinitis. There are often at the same time hemorrhages in the vitreous.

Retinitis from Exposure to Direct Sunlight.—A limited central area of retinitis may be caused by prolonged exposure to direct sunlight, such as is occasioned by staring at an eclipse without a protecting glass. Some cases recover; in others a permanent scotoma results.

The *treatment* of retinitis must be directed to alleviation of the general affection to which it is due, and the prescribing of such measures as are likely to benefit the affection of the eye itself.

In syphilitic retinitis the best results are obtained from the inunction of mercury. In all forms of retinitis, whether syphilitic or not, the administration of iodid of potassium and mercury promotes absorption of the inflammatory products.

The membrane affected should be allowed as much functional rest as possible. All work involving much use of the eyes must be avoided; dark glasses should be worn or the patient kept in a darkened room.

Retinal Hemorrhage.—Blood escaping from the retinal vessels may be located in the tissue of the retina, between the retina and the vitreous humor—*subhyaloid hemorrhage*—or in the substance of the vitreous humor.

If situated in the retina, it may be confined to the nerve-fiber layer, when it presents a striated and flame-shaped appearance; or it may extend deeper, even as far as the outer nuclear layer, and present various irregular shapes. The subhyaloid hemorrhages occur most frequently in the macular region; they raise the hyaloid membrane up over a circular area, but by the time they are seen ophthalmoscopically have usually assumed a semilunar or crescentic shape. The patient complains of sudden loss of sight, and often of seeing a red patch in front of the eye—a positive red scotoma. Hemorrhage from the retinal vessels may be due to diapedesis of blood through their walls or to rupture of them.

Diapedesis occurs when the condition of the blood is altered, and accounts for the retinal hemorrhages met with at times in the following diseases: diabetes, leukocythemia, anemia, scurvy, malaria, pyemia, and purpura.

Rupture of the vessel-walls may result from one or more of the following causes: undue weakness of them, increased pressure within them, and sudden diminution in the support afforded by the structures around them.

In the various forms of retinitis the vessel-walls become softened. As the part of general arterial disease, or as a local affection resulting from increased tension of the eye, they may become thickened and unduly brittle. Increase in the intravascular pressure may be due to general or local causes. As an example of a general cause may be quoted the congestion caused by straining during violent expiratory efforts, such as occurs in constipation and that resulting from sudden arrest in the menstrual flow.

A local increase of intravascular pressure is brought about by pressure on the central vessels of the optic nerve, either from inflammatory effusion, as in optic neuritis, or from new growth. It is also occasioned by thrombosis of a retinal vein, which is one of the commonest causes of retinal hemorrhage, and gives rise to appearances which are frequently spoken of as *hemorrhagic retinitis*.

The main trunk of the vein in the nerve may be the seat of the obstruction, or only a branch of it; in the latter case the hemorrhages are confined to the area supplied by that branch.

If the main trunk is blocked, numerous hemorrhages are seen scattered at various depths over the retina, and there is a general cloudiness of the membrane. Only one eye is usually involved, and the cause of the thrombosis is generally a phlebitis of gouty origin.

Embolism of the Retinal Arteries.—Embolism of a retinal artery is liable to occur in the course of any affection in which blood-clots enter the circulation, the most frequent of these being heart disease.

The main trunk, or one of its branches only, may become blocked. When there is embolism of the central artery the patient complains of complete blindness of one eye,

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coming on suddenly. Ophthalmoscopic examination shows at first marked narrowing of the arteries without much alteration in the veins. In the course of a few hours an opaque cloudy whiteness of the retina makes its appearance, most marked around the optic disk and yellow spot. As the retina at the yellow spot itself is thinner than elsewhere, the reflex from the choroid is not so much obscured in that position; and by contrast with the surrounding whiteness it stands out as a spot of a bright cherry-red color. After a time the retina clears, but becomes completely atrophied; the optic disk becomes white, and permanent blindness is established.

When only a branch of the central artery is blocked the changes are confined to the area of the retina supplied by it. Occasionally the whole of the retina is not supplied by the central artery, a branch going to the macular region from one of the ciliary arteries, a *cilioretinal artery*. Should this be the case, and should embolism of the central artery occur, the cilioretinal artery not being blocked, central vision will be retained though peripheral vision is abolished.

The ophthalmoscopic appearances above described as those of embolism of the central artery are the same as those which follow any sudden stoppage of the blood-supply to the retina, whether it is produced by embolism, thrombosis, hemorrhage into the optic-nervey sheath, or wound of the nerve.

The diagnosis between the several conditions must be made from the history of the case.

Treatment.—In embolism of the central artery of the retina treatment is only likely to be of benefit in the early stages of the affection. Then possibly the clot may be induced to break up and pass into smaller branches, so restoring some of the blood-supply. To try to bring this about, dilatation of the vessels should be induced by administration of nitrite of amyl, and diminution of intra-ocular tension by paracentesis of the anterior chamber. Massage of the eyeball is also recommended.

Atrophy of the Retina.—Atrophy of the retina may occur secondary to inflammation, or as the result of arrest in its blood-supply, either from embolism or thrombosis. It may also be a primary affection of a slowly progressive character, affecting both eyes, usually accompanied by pigmentation, and commonly termed *retinitis pigmentosa*. This disease begins early in life, if not at birth, and goes on steadily increasing.

The periphery of the retina is the part first affected, which leads to contraction of the field of vision. In the early stages of the disease the contraction of field can only be detected in dull lights; later, it is apparent in bright light, also. In the course of years, as the atrophy slowly extends, so the field of vision gradually becomes smaller and smaller, until ultimately the yellow-spot region is involved and central vision is lost.

The first symptom the patient usually notices is an inability to see well at night—*nyctalopia*. On ophthalmoscopic examination, in the large majority of cases black spots will be found in the peripheral parts of the retina, some round and some of an irregular branching shape, like bone-corpuscles. The branching processes of contiguous patches may become united and so form a network. As the atrophy advances the pigmentation approaches nearer and nearer to the optic disk. The retinal arteries gradually become reduced in size, and the optic disk becomes paler and paler.

In advanced cases opacities form at the posterior pole of the lens. All the symptoms of the disease may be present without the pigment-patches, small white spots being seen in the retina instead.

The parents of patients affected are sometimes found to be related. It is frequently an hereditary affection, and can be traced through several generations. It is not uncommonly met with in deaf mutes.

No known treatment will arrest the progress of the disease; occasionally a temporary improvement can be obtained by the use of the constant current, or of vascular dilators, such as nitrite of amyl or nitroglycerin.

Detachment of the Retina.—The defect of vision of which a patient with detachment of the retina complains is often compared to a cloud in front of the sight, limited to a portion of the field, which in some cases makes its appearance suddenly.

The ophthalmoscopic characters of a detachment of the retina vary with its extent and duration. In slight and early cases, the retina and the fluid beneath it being still transparent, the red reflex of the choroid is not obscured. The retinal vessels over the detached area are, however, smaller than usual, presenting an unnaturally stiff and bent appearance, and showing no light-reflex on their surface.

On examination by the direct method, it will be found that a different lens is required to see the vessels in the detached area from that required for the rest of the fundus. Thus, if the patient is an emmetrope, no lens is required to see the optic disk; but a plus lens is necessary to see the surface of the detachment. If he is highly myopic, and the detachment is not very deep, a lower minus glass will be required to view the detached area than is wanted for the optic disk.

If a detachment of the retina has existed for some time, or if it is very deep, or has a new growth or an opaque fluid behind it, then the red reflex over the region of the detachment is diminished or abolished. A gray area is seen instead, which presents light and dark portions, due to folds formed in the detached membrane. In a large proportion of cases a hole can be seen in the detached part of the retina; and sometimes the detached membrane is observed to oscillate on movements of the eye.

Detachment of the retina is most frequently met with in patients who have a high degree of myopia; the abnormally fluid condition of the vitreous humor which is commonly present in that condition favors its development. Detachment of the retina may also occur as the result of injuries, in connection with new growths, and sometimes in elderly people without obvious cause.

The result of **treatment** in cases of detachment of the retina is seldom satisfactory. In recent cases, by keeping a patient in bed in the horizontal position for some weeks, an improvement in vision can be obtained. As soon, however, as the patient again gets about the defect returns, and becomes as bad as before. A few cases have been permanently benefited by the operation of puncturing the sclera and choroid and allowing the subretinal fluid to escape, the operation being followed by prolonged rest in bed. Hypodermic injections of pilocarpin have been tried by many, but not with very encouraging results.

Glioma of the Retina.—Glioma of the retina is a very malignant form of round-cell growth which occurs only in childhood. It may be present at birth, is usually met with during the first three years of life, and never begins later than the eleventh year.

The symptom which usually attracts attention first is a bright reflex of a yellowish color, seen through the pupil.

If the growth is on the outer surface of the retina—*glioma exophytum*—and if that membrane is much pushed forward in front of it, the retinal vessels will be seen close behind the lens; if the tumor grows from the inner surface of the retina—*glioma endophytum*—the retinal vessels are hid from view by it, and detached nodules of growth often form in the vitreous.

As the tumor grows, the globe expands and ultimately becomes perforated by it. The tumor then protruding through the perforation, and no longer being confined under pressure, tends to grow in a luxuriant way, forming a large fungating, bleeding mass—*fungus hæmatoides*. The patient dies either from exhaustion or from complication arising from secondary growths. In a large proportion of cases both eyes become affected independently by the growth, sometimes with an interval as long as three years.

Secondary growths of glioma are most frequently met with in the nervous system, or subperiosteally about the face or cranium.

Treatment.—The early removal of an eye with glioma of the retina is most important, since by so doing the life of the child may be saved. The optic nerve should be divided as far back as possible, as the growth tends to spread down the nerve.

AFFECTIONS OF THE OPTIC NERVE.

Neuritis.—In inflammation of the optic nerve the whole or only a portion of the nerve may be involved. When only a portion of it is affected the inflammation may be localized in different regions. It may be confined to the intra-ocular portion or the papilla.

Simple Papillitis.—The part behind the eyeball may alone be inflamed—*retro-ocular* or *retrobulbar neuritis*. In this latter form it is frequently not all the fibers of the nerve which become affected; those which supply the macular region may be selected—*axial neuritis*. In rare cases the axial fibers are unaffected, and those which go to the peripheral parts of the retina are the ones picked out—*perineuritis*.

An inflammation beginning as a papillitis may extend backward past the lamina cribrosa to the retro-ocular portion of the nerve—*ascending neuritis;* and likewise one beginning as retro-ocular neuritis may extend downward to the papilla—*descending neuritis.*

When the intra-ocular end of the nerve is affected the optic disk is seen to be altered in color, often having a mottled surface and an ill-defined striated margin. It appears larger in circumference than normal, and is raised above the surface of the surrounding retina. The amount of swelling of the optic disk varies with the character of the inflammation, being most marked when the effusion is serous—*choked disk*—and least when it is plastic and cellular. The latter form is the most likely to be followed by atrophy and permanent loss of vision. In papillitis as the result of compression the retinal vessels become altered, the arteries being narrowed, and the veins distended and tortuous. When the swelling is very marked the vessels on the disk may for a short distance be obscured from view.

As the inflammation subsides the outlines of the disk gradually become more defined; it becomes paler, assuming a grayish-white color, and the retinal vessels become narrowed. Some irregularity in the margin of the disk often persists, and in its neighborhood white lines appear at the borders of the vessels—*post-neurotic atrophy.*

The amount of disturbance of vision in the early stages of optic neuritis varies considerably: there may be complete blindness, or scarcely sufficient defect to attract the patient's attention. The resulting permanent defect depends on the amount of atrophy.

In retrobulbar neuritis there are at first either no ophthalmoscopic changes in the disk or only very slight ones. The diagnosis has to be made from other symptoms, such as defects in the field of vision, or the presence of a central scotoma, either absolute or only for colors. Later, pallor of a portion or the whole of the optic disk, due to atrophy, may make its appearance.

One of the most frequent causes of optic neuritis is cerebral tumor—

sarcomatous, gliomatous, tubercular, or syphilitic. Both eyes are usually affected, one earlier than the other, and the amount of swelling of the papilla is generally considerable. The patient also usually complains of headache and sickness. The way in which optic neuritis accompanying cerebral tumor is occasioned has been the source of much discussion.

Some believe it to be a true descending neuritis. Others, an edema, rather than an inflammation, caused by compression of the central veins, which they regard as being brought about by the increased pressure in the cranial cavity forcing cerebrospinal fluid out into the intervaginal space around the nerve. Meningitis, whether tubercular, syphilitic, traumatic, or secondary to middle-ear disease, may give rise to descending neuritis.

Optic neuritis is also met with in connection with the acute specific fevers, anemia, and great loss of blood.

Syphilis, besides causing optic neuritis in the ways already mentioned, may involve the nerve directly.

Tobacco sometimes gives rise to chronic retrobulbar axial neuritis, the most striking symptom of which is that the patient complains of a dimness of sight, which is worse in the daytime or in bright light. Both eyes are usually affected; in the early stages there are no ophthalmoscopic changes or only slight hyperemia of the papilla to be seen; later on, pallor of its temporal half can be made out.

A relative or absolute central scotoma for red and green will always be found. This *tobacco-amblyopia* may be brought on either by smoking or chewing, and it usually follows the use of the stronger forms; *i. e.*, those containing a large quantity of nicotin. As a general rule the vision tends gradually to improve as soon as the use of the noxious agent is discontinued. The amount of tobacco required to produce this affection varies considerably, some people being unusually susceptible to its influence. Excessive use of alcoholic liquors predisposes to its development. Diabetics are particularly liable to be affected.

There are some grounds for thinking that excessive use of alcoholic liquors and diabetes, independently of tobacco, may give rise to chronic retrobulbar neuritis. It is known to follow chronic poisoning by lead, and also by disulphid of carbon.

Acute retrobulbar neuritis comes on often without any apparent cause, or only with the history of a previous chill. The loss of sight is exceedingly rapid, sometimes complete; and no ophthalmoscopic changes may be seen which will adequately account for it.

There are usually also at the same time headache and pain deep in the orbit, which is intensified on pressure of the eyeball backward.

There is a form of neuritis which affects several members of one family, usually the males. The cases commence like those due to tobacco poisoning, but, unlike them, show no tendency to improve under treatment, going on to atrophy of the macular fibers and complete loss of central vision—*hereditary optic atrophy.*

Treatment.—In the treatment of optic neuritis the drugs most likely to prove beneficial are potassium iodid and mercury. Blood should be taken from the temple by means of Heurteloup's artificial leech, or blisters be applied to it. The eye should be rested by the avoidance of close work and the wearing of dark smoke-tinted glasses.

In cases of tobacco-amblyopia smoking must be completely given up, and a mixture containing potassium iodid, and in the later stages small doses of liquor strychniæ, prescribed.

Should other toxic agents be suspected as the cause of the affection, avoidance of the process by which they have entered the system must be insisted on.

Atrophy of the Optic Nerve.—Atrophy of the optic nerve may be the result of inflammation—*post-neuritic atrophy;* or of a primary change—*simple atrophy.* The mode of onset and appearances of the post-neuritic form have been described.

In simple atrophy the optic disk is of a white or bluish-white color, and its margins are sharply defined. As the disease progresses the disk becomes cupped, and the fibers of the lamina cribrosa are exposed as grayish markings. There is no depression backward of the lamina cribrosa, as in glaucoma, and consequently no overhanging margins to the cup. The retinal vessels are not altered in size so much as in post-neuritic atrophy, and they do not have white lines forming at their margins, as in that affection.

The cause of simple atrophy is often obscure. It may occur in the course of spinal or cerebral affections. It is not uncommonly an early symptom in tabes dorsalis, and is met with in disseminated sclerosis, congenital idiocy, and general paralysis of the insane.

Pressure on the nerve interfering with its conducting power leads to atrophy. The pressure may occur in the orbit or cranium, from inflammatory effusions or new growths.

After severe blows on the head blindness of one eye sometimes rapidly follows without at first any ophthalmoscopic changes ; later, atrophy sets in. The blindness in these cases may be caused by injury to the nerve in a fracture of the skull passing through the optic foramen, or by pressure on the nerve from hemorrhage into its sheath.

The **treatment** of optic atrophy, apart from that of the affection which has given rise to it, consists in the administration of nervine tonics, such as hypodermic injections of strychnin, in the application of the constant current to the eye, and in the production of vascular dilatation by nitrite of amyl or nitroglycerin.

Unfortunately, treatment seldom has much effect on the progress of the disease.

INJURIES OF THE EYE.

Injuries of the eye may be conveniently divided, for practical purposes, into those which do and those which do not give rise to perforating wounds. Injuries which do not give rise to a perforating wound include foreign bodies in the cornea or beneath the lid, abrasions of the cornea, wounds of the conjunctiva, superficial burns of the eye, concussion-injuries, and subconjunctival ruptures.

Foreign Bodies in the Cornea or Beneath the Eyelid.—Foreign bodies, such as chips of metal, very frequently lodge in the anterior part of the cornea, being prevented from going deeper by the resistance afforded by Bowman's membrane.

If a patient complains of a foreign body in the eye, the surface of

the cornea should first be searched by oblique illumination; if nothing is seen in it, the inner surface of the lids must be examined. The whole of the inner surface of the lower lid and lower conjunctival cul-de-sac can be exposed by drawing the lid down. In order to evert the upper lid, the patient must be directed to look downward; the surgeon then grasps the eyelashes with the first finger and thumb of his right hand, and draws the eyelid away from the globe, at the same time pressing on the surface of the lid, above the upper margin of the tarsus, with a probe or the first finger of his left hand. (For removal of foreign bodies from the cornea, see Operations.)

Abrasions of the Cornea.—Slight abrasions of the cornea are often very difficult to detect, but are readily shown up by the application of a drop of a 2 per cent. solution of fluorescin, when the denuded area stains a bright-green color. Abrasions of the cornea are generally accompanied by much pain, photophobia, and lacrimation, which is best relieved by the application of atropin, and by tying the eye up with a compress and bandage. If there is reason to suppose that the abrasion is infected, or is likely to become so, iodoform should be combined with the atropin, and applied in the form of an ointment. Cocain should not be prescribed in these cases, as the relief to pain which it affords is only temporary, and it tends to soften the epithelium and delay healing.

Wounds of the Conjunctiva.—Wounds of the conjunctiva usually heal rapidly. When the edges are widely separated, they should be drawn together with fine silk sutures.

Burns of the Eye.—In burns of the eye, or destruction with lime, acids, or alkalies, if the corneal epithelium is alone involved, it will appear white and opaque, can be easily wiped off, and will re-form without leaving permanent damage. Usually, however, the deeper structures are also affected, and a considerable slough forms. In such cases a very guarded prognosis should be given when the patient is first seen, as the condition tends to become more severe than it appears directly after the injury.

In a recent case any of the damaging substance, if still present, should at once be removed. Every particle of lime should be sought for and wiped away; any acid or alkali neutralized by a weak lotion of the opposite reaction; and afterward a boric-acid ointment, made with vaselin, should be applied. In cases in which there is a large area destroyed, it is not well to tie up the eye, as plastic exudation is thrown out and the lid becomes united to the globe—*symblepharon.* The patient should be instructed to draw the lid away from the eye several times a day, so as to break down such adhesions.

Concussion-injuries.—As the result of concussion of the eye from blows on it by blunt objects, various lesions may result. Among these lesions are separation of the iris for a portion of its circumference from the ciliary body—*iridodialysis;* rupture of the sphincter muscle of the iris; rupture of the lens-capsule, and formation of opacity of the lens from the action of the aqueous humor on it—*concussion-cataract;* rupture of the suspensory ligament of the lens and *dislocation of the lens,* either forward into the anterior chamber, laterally, or backward into the vitreous chamber; *rupture of the choroid,* so that

ophthalmoscopically a strip of white sclerotic can be seen through it, with pigmentation at the margins; and *detachment of the retina.* In concussion-injuries there is often at first much intra-ocular hemorrhage, and the exact extent and nature of the injury cannot be diagnosed until this has been absorbed.

The first **treatment** in such cases is the application of atropin and a cold compress.

If the lens has become dislocated there is great danger of glaucoma ensuing. When the lens is displaced backward into the vitreous chamber, the iris having lost its support posteriorly is seen to oscillate on movements of the eye—*iridodonesis.*

Operations on eyes with dislocated lenses are, as a rule, most unsatisfactory procedures; the suspensory ligament being torn through, vitreous is likely to escape. The surgeon is, however, forced to operate sometimes in these cases, in order to relieve pain and tension. If the lens is dislocated into the anterior chamber, its removal should be attempted. If it is dislocated into the vitreous and the tension is raised, it is better to perform an iridectomy, rather than attempt the difficult task of catching and extracting the lens with a scoop.

FIG. 418.—Lateral half of an eyeball, with lateral dislocation of the lens, giving rise to secondary glaucoma. The root of the iris is in contact with the periphery of the cornea; the optic disk is cupped; the vitreous humor is detached from the retina posteriorly.

Ruptures of the Eyeball.—When the eyeball ruptures as the result of a blow on it from a blunt object, it does so nearly always in the same locality—*i. e.,* 2 or 3 mm. from the sclerocorneal margin, and concentric with it—on the opposite side of the eye to that on which the blow was inflicted. As the eyeball is protected above by the brow and on the inner side by the nose, blows are most frequently received from the lower or outer sides; and the most frequent position of the ruptures is upward or inward.

The conjunctiva over the ruptured sclerotic may or may not remain intact.

The lens, iris, or vitreous may escape through a rupture; and, if the conjunctiva is not torn, may be retained beneath it. In this way, what is termed *subconjunctival dislocation of the lens* is occasioned.

In many cases of rupture of the globe the damage to its contents is so great that it is best to excise the eye at once.

In a case of subconjunctival dislocation of the lens, in order to avoid opening up direct communication with the interior of the eye, the lens should, if possible, be left until the scleral wound has healed, and then be removed.

Perforating Wounds of the Eye.—Whenever there has been an opening made into the globe, the possibility of the occurrence of sym-

pathetic ophthalmia is established; and the probability of its coming on depends on the position of the wound, the character and condition of the wounding substance, and the amount of reaction that follows. Operations on the eye that are planned to avoid the ciliary body (the dangerous region), and that are performed with aseptic instruments, are rarely followed by sympathetic mischief, though it does occasionally occur after operations for cataract or glaucoma.

In perforating wounds of the eye various structures may be involved. Simple wounds of the cornea generally heal well and quickly. In a wound of the cornea with prolapse of iris, it is important to draw out and cut off the prolapse as early as possible, before it has had time to form adhesion to the sides of the wound.

If the lens is wounded, it is liable to swell up and give rise to increase of tension, pain, and irritation, in which case it requires to be evacuated. Eyes in which the ciliary body and lens are wounded should be at once eviscerated or excised. The amount of useful sight which a patient is likely to retain in such an eye is not sufficient to make it worth his while running the great risk of sympathetic ophthalmitis which a wound in that situation entails.

In wounds of the ciliary body in which the lens is not involved and remains clear, it is often exceedingly difficult to decide what course is best to pursue. It is generally well to watch the case for a few days, and if much reaction sets in, to advise excision at once.

In a perforating wound behind the ciliary region, if not very extensive, any protuberant vitreous should be cut off, and its edges be drawn together by sutures passed through the conjunctiva and episcleral tissue.

If, after a perforating wound, suppuration sets in and seems likely to spread, the eyeball should be eviscerated or excised. In cases of perforating wound of the eye, it is often a matter of considerable difficulty to determine whether or not a foreign body has remained in the eye. The history of the accident must be carefully inquired into to determine this point, and also to ascertain the nature of the foreign body, should it have become implanted.

If a piece of steel can be seen lodged in the eye, or if the history of the accident is such as to lead the surgeon to suspect its presence, an attempt should be made to remove it with an electromagnet. This is most likely to prove successful should the piece of steel be situated in the anterior chamber or lens. If a foreign body cannot be removed from an eye, excision of the globe generally becomes necessary. If, however, the foreign body can be seen, with the ophthalmoscope, in the vitreous chamber behind the ciliary region, and the eye remains free from irritation, it may be left.

A shot will sometimes pass through an eyeball and become lodged in the orbit. In these cases, occasionally the places of entrance and exit of the shot can be seen with the ophthalmoscope.

DISTURBANCES IN THE MOVEMENTS OF THE EYEBALL.

In the normal condition the two eyes are always so directed that the image of the object looked at falls on the two yellow spots. When either eye deviates so that the image falls on some other part of the retina, the patient is said to *squint*, or have *strabismus*. The deviation may be due to paralysis of one or more muscles of the eye—*paralytic strabismus;* or there may be deviation without any loss in the power of movement of the eyes—*concomitant strabismus*. In some of these latter cases the deviation is always in one eye—*monocular strabismus;* in other cases it varies, being sometimes in one eye and sometimes in the other—*alternating strabismus*. Deviation in the eyes is most frequent in the horizontal direction, either outward or inward—*divergent* or *convergent strabismus;* but it may be vertical, either upward or downward.

A squint is *latent*, or there is *insufficiency of a muscle*, when the deviation only becomes manifest on covering one eye while the patient's attention is fixed on some object with the other. That is to say, when the normal parallelism of the eyes is only maintained by the desire for binocular vision.

The following terms, introduced by G. T. Stevens, describe the various forms of muscular balance of the eyes: *orthophoria*, when the visual lines tend to be parallel; *heterophoria*, when the visual lines are not parallel; *esophoria*, when the visual lines tend inward; *exophoria*, when the visual lines tend outward; *hyperphoria*, when the visual lines tend to be one above the other.

A constant involuntary oscillating movement of the eyes is termed *nystagmus*. The movements vary, both with regard to their direction and rapidity, in different cases. They may be lateral, vertical, or rotatory; or two forms may be present in one case. The movement may be of a slow, twitching character; or so rapid that the outline of the cornea can hardly be distinguished. In some cases, so slight is the movement that it is only detected on ophthalmoscopic examination, as a jelly-like shaking of the vitreous humor.

The movements of the eyeballs are controlled by the four recti and two oblique muscles of each side, which are supplied by the third, fourth, and sixth cranial nerves. These take origin in nuclei in the floor of the Sylvian aqueduct and the fourth ventricle, which nuclei are controlled by higher centers in the cerebral cortex. Disorders in the movements of the eyeball may therefore result from disturbances in the muscles themselves, in the nerve supplying them, in the nuclei of origin of the nerves, or in the centers in the cerebral cortex.

Disturbances in Movements of the Eye Due to Defect in the Muscles.—A few cases of paralytic strabismus have been recorded in which the muscles have been found congenitally defective, either absent, ill-formed, or inserted in an unusual position on the globe. The presence of such abnormalities can only be certainly determined after death or on operation.

The muscles may be disturbed in their action as the result of wounds, or from pressure on them by orbital growths.

The unskilful division of a muscle in the operation of tenotomy is sometimes the cause of loss of power in it; as, for example, when it is

divided too far back by cutting on the outer, instead of the inner, side of the hook.

Disturbance in Movement of the Eye Due to Interference with the Nerves Supplying Them or with the Nuclei of Origin of the Nerves.—These two classes of cases may be dealt with together, because it is only in rare instances that it can be definitely determined during life to which class the paralysis should belong. Syphilis, injury, sudden chills, and diphtheria are the causes to which paralysis of the extra-ocular muscles have been attributed.

A lesion of the nerves may be situated in the orbit, in the sphenoidal fissure, or in the cranium. In most of the cases the paralysis is found to correspond to the distribution of one or more of the nerves. The eye deviates away from the paralyzed muscle by the overbalancing tonic contraction of its unaffected opponent, and the patient complains of diplopia.

In complete paralysis of the third nerve the eyelid droops—*ptosis;* there is loss of power in moving the eye upward, inward, or downward. The eye rolls outward, through the unopposed action of the external rectus, and slightly downward, through the unopposed action of the superior oblique. The pupil is dilated; and there is loss of power in accommodation for near objects. On raising the upper lid the patient sees double, the images being crossed.

Third-nerve paralysis is often incomplete, some of the muscles supplied by it being unaffected; or all the muscles it supplies may be involved, but the power of movement in them only lessened, not completely abolished. In paralysis of the superior rectus, there is crossed diplopia on the patient looking up, the false image being highest and somewhat tilted. In paralysis of the inferior rectus, there is crossed diplopia on the patient looking down, the false image being lowest and somewhat tilted. In paralysis of the internal rectus, there is crossed diplopia on the patient looking to the sound side. In paralysis of the inferior oblique, there is homonymous diplopia on the patient looking up, the false image being highest and tilted. In sixth-nerve paralysis there is inability to move the eye outward, and the eye rolls inward through the unopposed action of the internal rectus; there is homonymous diplopia on the patient looking to the paralyzed side. In fourth-nerve paralysis the eye is only slightly displaced upward and inward; often no deviation can be detected. The condition can only be definitely diagnosed by the character of the diplopia, which is homonymous, and present when the patient looks down, the false image being the lowest and somewhat tilted.

Treatment of Disturbances in Movements of the Eye.—In recent cases of paralysis of the ocular muscles potassium iodid should always be prescribed, whether the lesion is supposed to be syphilitic or not; and in most cases marked improvement will result. When the diplopia is found to be very troublesome, a shade should be worn over the affected eye. In cases which do not improve or completely recover under medicinal treatment, electricity, in the form of the constant current, should be locally applied. In cases of long standing, in which the antagonistic muscle has become secondarily shortened, tenotomy must be performed and the paralyzed muscle advanced.

In the treatment of **convergent strabismus,** it is first necessary to have the patient's eyes thoroughly under the influence of atropin, and to estimate the total amount of hypermetropia. In an early case, when the power of accommodation has been abolished, the squint generally becomes for the time much less or disappears. The patient should be ordered glasses equal to quite two-thirds of his total amount of hypermetropia, to be worn constantly.

The earlier in a case this treatment is adopted the more likely is it to prove effectual; about half the cases that present themselves are ultimately cured by it alone. If, after glasses have been worn for a year, no improvement whatever has resulted; or if, after several years, there is still much convergence, a tenotomy of the internal rectus muscle must be performed. In extreme cases tenotomy of both internal recti or advancement of the external rectus will be required.

It is never advisable to operate on a child without having first tried the spectacle treatment; and it is never advisable to divide both internal recti at the same time. If these points are not adhered to, secondary divergence is liable to be produced. In a case of secondary divergence the internal rectus muscle must be advanced, and tenotomy of the opposing external rectus performed.

In cases of divergent strabismus with myopia, minus glasses, correcting the whole or a portion of the refractive error, should be ordered for near work, so as to stimulate a normal accommodative action in the ciliary muscle. In marked cases tenotomy of the external rectus or advancement of the internal rectus becomes necessary.

DISEASES OF THE LACRIMAL APPARATUS.

Diseases of the lacrimal apparatus may be divided into those of the secretory gland and those of the system of drainage for the tears from the eye to the nose.

Diseases of the lacrimal gland are exceedingly rare, and call for but little comment. The gland may be acutely or chronically inflamed, the seat of simple hypertrophy, of cysts, or malignant growths. The tears may overflow the margin of the eyelid, either because there is excess of secretion—*lacrimation*—or because there is some defect in the system by which they are drained into the nose—*epiphora.*

Epiphora is brought about in a variety of ways. The relation of the lids to the eyeball may be altered, so that the puncta lacrimalia are no longer turned in toward it, but are everted. This occurs in facial paralysis and in ectropion of the lower lids.

The puncta or canaliculi may be congenitally absent, or have been cut across by a wound of the eyelid. They may be obstructed by a foreign body, such as an eyelash, and in rare cases by a mass of fungus-growth—*Streptothrix Foersteri,* or chalky concretions—*dacryoliths.*

The most common cause of epiphora, however, is obstruction to the nasal duct, caused usually by thickenings of its mucous lining, the result of disease spreading from the nasopharynx; also, in some cases, by syphilitic periostitis. The stricture may be met with in any part of the duct, but is most frequently located at its upper extremity, at the

point of junction with the lacrimal sac. It is an affection more common in women than in men.

Obstruction to the nasal duct causes the tears to collect in and distend the lacrimal sac, the walls of which consequently become thickened and chronically inflamed—*chronic dacryocystitis* or *mucocele.* When the lacrimal sac is distended, a swelling is formed at the inner canthus, from which, on pressure, fluid can be made to regurgitate through the canaliculi.

Sometimes acute inflammation occurs in the lacrimal sac, the skin overlying it becoming red and tender, and on pressure pus regurgitates from the canaliculi—*acute dacryocystitis.* The inflammation tends to spread to the cellular tissue around the sac, and hard, brawny induration develops.

If the obstruction to the duct is not relieved, an abscess forms—*lacrimal abscess*—which points at a spot a little below the tendo oculi. A communication externally is then established with the lacrimal sac—*lacrimal fistula*—which will be kept open permanently by the escape of discharge or tears until the obstruction in the duct is opened up.

Treatment of Epiphora.—When the puncta is everted, opening of the canaliculus on its inner wall, that facing the eyeball, will often greatly relieve the overflow of tears. When there is a stricture in the duct, it must be dilated by passing probes gradually increasing in size, the canaliculus having first been slit into the sac. To maintain the dilatation, the probing has to be repeated at intervals of a few days for some weeks, or a style must be inserted and worn constantly for about a month. The probing is a very painful process, and in nervous patients or in children it is best to administer an anesthetic, dilate the stricture until a No. 6 probe passes easily, and then insert a lead style.

AFFECTIONS OF THE EYELIDS.

The skin of the eyelids are liable to most of the diseases which affect the skin in other parts of the body. There are, however, owing to certain anatomical peculiarities, affections of the lid of a special character, which call for description in connection with diseases of the eye. These anatomical peculiarities are the loose attachment of the skin to underlying structures; the fact that it is a free border with a terminal circulation, and the seat of junction of mucous membrane and skin; and the presence in it of various large glands and large hair-follicles.

Inflammation of the Borders of the Lids.—The margins of the lids are exceedingly liable to become the seat of inflammation—*marginal blepharitis.* The skin becomes reddened, and there is formation of either little flaky scales—*blepharitis squamosa*—or of little pustules around the hair-follicles—*blepharitis pustulosa.* An eyelash is seen to pass through the center of each pustule. These pustules break down, leaving little ulcers, with scabs of coagulated discharge on the surface—*blepharitis ulcerosa.*

When suppuration forms around the hair-follicle, the root of the cilium is destroyed. The affection may go on until nearly all the eyelashes are lost and the lids left bald—*madarosis.* The cicatrization which follows the ulceration may cause eversion of the margins of the

lids, so that the reddened mucous membrane of the conjunctiva becomes exposed—*lippitudo.*

The punctum lacrimale sometimes becomes drawn away from the eye—*eversion of the puncta*—and troublesome epiphora ensues. Occasionally the contraction caused by the cicatrization displaces the eyelashes, so that they are turned inward toward the eyeball and rub against its surface—*trichiasis.*

Marginal blepharitis is frequently complicated with a chronic inflammation of the conjunctiva. Care has to be taken to diagnose between a chronic conjunctivitis with coagulated discharge adhering to the margins of the lids, and a marginal blepharitis complicated with conjunctivitis. The crusts adhering to the margin of the lids must be wiped away, and the skin beneath examined to see if it is injected, as it will be if it is inflamed.

Some individuals are particularly prone to marginal blepharitis, which may begin in childhood and last for years. Many of the children who suffer from it are debilitated in health or are the subjects of scrofula or tubercle. Exposure of the eyes to air vitiated from smoke, dust, or irritating vapors tends to favor the development of this affection ; as also do want of sleep and the use of the eyes for near work with uncorrected errors of refraction, especially by artificial light. Whatever tends to excite lacrimation or overflow of tears, by keeping the margins of the lids moist, favors the development of inflammation in them.

Treatment.—The treatment of marginal blepharitis consists in the improvement of the patient's general health with tonics, cod-liver oil, good food, and healthy surroundings ; the removal of any irritating cause, or the protection of the eyes with glasses when exposed to noxious influences ; the correction of errors of refraction, and the alleviation of any conjunctival or lacrimal affection, should such be causing lacrimation or epiphora. A warm alkaline lotion made with glycerin of borax, 1 : 8, is the best for bathing the eyelids in order to soften and remove the gummy discharge.

A mercurial ointment made with the nitrate, the yellow oxid, or the white precipitate, and vaselin should afterward be rubbed on to the margins of the lids.

Affections of the Glands of the Eyelids.—The glands which open at the margin of the lid, like the glands of the skin elsewhere, occasionally become distended with their own secretion. Some individuals are exceedingly liable to the formation of a succession of little clear vesicles along the palpebral border, which are probably due to obstruction in the duct and distention of the large sudoriferous glands, the glands of Moll.

An accumulation of secretion in the Meibomian glands gives rise to yellow spots or lines, which are seen through the conjunctiva ; by pressure of the inner surface of the lid against the finger-nail this secretion can be squeezed out. In elderly people in whom the secretion has been retained for a long time, salts of lime are liable to become deposited in it. A Meibomian gland or one of the sebaceous glands (Zeiss's glands) connected with an eyelash-follicle, which is impacted with secretion, will not uncommonly become inflamed. Such inflam-

mation around one of the glands of the lid, when suppurative, is termed a **hordeolum.** If one of Zeiss's glands be affected—*hordeolum externum*—a little red, hard, exceedingly tender and painful tumor forms at the margin of the lid, with some edema of the tissue around it. Gradually, as the pus makes its way to the surface, a yellow spot will appear in the skin overlying the swelling, where it will ultimately burst.

Inflammation around one of the Meibomian glands, when acute and suppurative—*hordeolum internum*—gives rise to a swelling of the substance of the lid, together with a good deal of redness and brawny thickening. A yellow area forms on its inner surface and the pus bursts through the conjunctiva, not through the skin, as in hordeolum externum.

The Meibomian glands are more subject to a chronic non-suppurative form of inflammation than to the acute form just described. A hard, rounded little nodule then appears in the lid, firmly attached to the tarsus, but having the skin freely movable over it—**chalazion.** In the region of the swelling, on the inner surface of the lid, a little discolored grayish area is seen. In this position the swelling may, after existing a long time, burst, and discharge a grayish gelatinous contents. A vascular granulation is often left at the seat of perforation.

Treatment.—In the early stage of a hordeolum the treatment consists in frequently bathing the lid with hot boric-acid lotion. As soon as the pus begins to show at the surface, an incision should be made into it. A chalazion should be incised from the inner surface of the lid, a vertical cut being made in the discolored area, and the substance afterward thoroughly scraped out with a small sharp scoop.

Displacement or Distortion of the Eyelids.—As the result of traction from cicatrization, the tarsus may become bent and the margin of one of the lids drawn outward away from the globe—*ectropion;* or turned inward toward it—*entropion.*

Cicatrization causing ectropion is most frequently the result of burns or injuries about the face; that which causes entropion is most often a sequela of granular ophthalmia. Paralysis of the orbicularis muscle will also produce ectropion, and its spasmodic contraction entropion.

When the margin of the lid is turned in toward the globe, the lashes continually rubbing against its surface cause considerable irritation, and may give rise to opacity, vascularity, or ulceration of the cornea. Some of the eyelashes may become drawn in toward the globe, usually as the result of ciliary blepharitis, without much bending of the margin of the lid—*trichiasis.* Occasionally, as a congenital abnormality, a second row of eyelashes is present, which, instead of being directed outward, turn inward toward the eye—*distichiasis.*

As the result of ectropion, closure of the palpebral aperture may be rendered impossible, or only possible on a great effort being made; such a condition is spoken of as *lagophthalmos.* It may also result from undue shortness of the lid, either congenital, or due to loss of skin from injury or ulceration. As the result of burns or ulceration, the margins of the lids may become united—*ankyloblepharon.*

Drooping of the upper lid—*ptosis*—may be congenital or paralytic. In the congenital form the levator palpebræ superioris muscle is absent, and there is also generally defective movement of the eye upward.

Improvement is effected by operations which form a band of adhesion between the tarsus and the occipitofrontalis muscle, which then, by its contraction, will raise the lid.

In the paralytic form of ptosis the third nerve may be at fault and the levator palpebræ paralyzed; or the cervical sympathetic nerve may be affected and Müller's muscle involved. This latter form is by no means common; in it the amount of ptosis is only slight; the pupil at the same time is generally contracted, and the eyeball slightly prominent.

An absence of a portion of one of the lids—*coloboma*—is either acquired and due to traumatism, or congenital. In congenital coloboma the inner half of the upper lid is the most usual seat of the defect.

A congenital abnormality is sometimes met with, due to a fold of skin stretching from the brow to the nose, overlying the inner canthus —*epicanthus*. It tends to become less as the bridge of the nose develops.

(For the treatment of ectropion, entropion, and trichiasis, see Operations.)

OPERATIONS ON THE EYE AND EYELID.

Anesthesia and Antiseptics in Ophthalmic Surgery.—The introduction of the local anesthetic cocain has greatly facilitated operative procedures on the eye. It has, however, its limitations. Complete anesthesia of the iris is not effected by its use; the pain occasioned by drawing on a tendon of one of the recti muscles with a strabismus-hook is not abolished. When the eyeball is congested or when the tension of the eye is increased, the anesthesia it produces is less complete.

For an operation on the eye, such as cataract-extraction, the application of a 2 per cent. solution of cocain hydrochlorate four times before the operation, at intervals of five minutes, is quite sufficient. For an operation on the eyelid from the conjunctival surface, such as incision of a chalazion or the expression of trachoma-follicles, a little of the solid cocain hydrochlorate should be allowed to dissolve on the part to be operated on.

A general anesthetic is necessary in operations for acute glaucoma, in excision of the eye, or evisceration. Also in most eye-operations on young children, and sometimes in extremely nervous individuals, where otherwise cocain would suffice.

In acute glaucoma chloroform is, from the operator's point of view, much to be preferred to ether, as under the former the patient's respirations are quieter and the eyes do not become so much congested.

The conjunctival sac cannot be rendered certainly aseptic by irrigation. It is well, however, to flush it thoroughly with some non-irritant antiseptic lotion, such as boric-acid lotion, just previous to operation. The skin of the lids and the eyelashes should also be well cleansed with the same lotion.

One of the simplest and safest ways to sterilize the instruments to be employed is to immerse them for ten minutes previous to the operation in carbolic-acid lotion, 1 : 20; and then just before using them to weaken the lotion to 1 : 50 by adding some recently boiled water.

For instruments with joints or teeth, like forceps, etc., boiling is strongly to be recommended. Knives can only be momentarily immersed in boiling water, otherwise their edges become blunted.

Operations on the Cornea.—For the **removal of a foreign body** from the cornea the surgeon should stand behind the patient, separate the lids with the first two fingers of his left hand, and, by pressing with them back on the globe, prevent it from rolling about. With a blunt-pointed spud in his right hand he should then partly lever and partly scrape the foreign body away. The after-treatment consists in applying atropin and keeping the eye tied up.

For **paracentesis of the anterior chamber** the instruments required are a broad needle and a curet. The lids can be separated and the globe fixed in the same way as for removal of a foreign body. The puncture is made at the corneal margin; as a rule, in the lower part. The lower lip of the wound is afterward slightly depressed with the curet to allow of the escape of the aqueous humor.

Operations for Conical Cornea.—Two only of the numerous operations that have been devised for conical cornea need be mentioned, the application of the galvanocautery and the excision of a wedge-shaped area.

By the destruction of a portion of the cornea at the apex of the cone with a fine point of the galvanocautery and the ensuing cicatrization a certain amount of flattening can be brought about. The advantage of the operation is that the cornea need not be perforated, so that it is unlikely to be followed by any complication. Its disadvantage is that a considerable amount of opacity is usually left in the direct axis of vision, which may necessitate a subsequent iridectomy. In the removal of a small wedge-shaped area of corneal tissue from the apex of the cone with a Graefe's knife and a fine pair of forceps, the resulting opacity is usually less. As, however, the anterior chamber has to be opened, there is considerable risk of the formation of an anterior synechia or an opacity of the lens.

Tattooing of the cornea is an operation performed for the purpose of blackening, and so rendering less conspicuous, unsightly white opacities of the cornea.

A thick solution of India ink is painted on the region of the leukoma; then by a number of punctures made with an ordinary cataract-needle the pigment is carried into the substance of the cornea. The India ink must be washed away from time to time, to enable the operator to judge of the effect he has produced.

Operations on the Sclerotic.—**Anterior Sclerotomy.**—In this operation, which is performed for glaucoma, the sclerotic is cut nearly through subconjunctivally, close to the corneal margin. A Graefe's knife is passed into the sclerotic, 1 mm. from the corneal margin, and carried across the anterior chamber to a point on the opposite side. By a slow sawing movement the sclerotic corresponding in extent to the upper third of the cornea is nearly divided in its whole thickness; the knife is then slowly withdrawn. Any extensive prolapse of iris into the wound must be combated by the use of eserin before and after the operation.

Posterior Sclerotomy.—The incision in this operation should be a

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meridional one, and made with a Graefe's knife. The point selected for it should be situated behind the ciliary body and between the recti muscles. It is performed for detachment of the retina, for extraction of foreign bodies from the vitreous, and sometimes as a preliminary to iridectomy in glaucoma.

Operations on the Iris.—Iridectomy.—The operation of removal of a portion of the iris is performed for (1) primary glaucoma, (2) to make an artificial pupil in cases of opacity of the cornea, and for (3) closed pupil the result of iritis. The instruments required are a speculum, toothed fixation-forceps, a short Graefe's knife or a keratome, iris-forceps, iris-scissors, and a curet or repositor.

For Glaucoma.—In performing an iridectomy for glaucoma the object is to remove a large portion of the periphery of the iris. Most operators now prefer to make the incision with a short Graefe's knife, because, when the anterior chamber is shallow and the lens pushed forward, there is considerable difficulty in steering the point of a keratome between the cornea and lens without wounding either of them.

The incision should be made in the same way as that for extraction of cataract (see page 836); but should be situated a little farther back, 1 mm. from the sclerocorneal margin, and not be so extensive. Great care ought to be taken to see that the point of the knife, when the first puncture is made, enters the anterior chamber; because with a shallow anterior chamber, in the endeavor to avoid wounding the iris, the knife may be easily passed between the layers of the cornea. The incision being completed, the conjunctival flap should be turned back and the iridectomy-forceps passed into the right-hand extremity of the wound. A fold of iris is then drawn out, and a snip made through it from the pupillary border to the ciliary attachment, on the right-hand side of the forceps. The portion of iris held in the forceps is then torn away from its ciliary attachment along the whole length of the wound and snipped off at its left-hand extremity. Finally, the iris at the angles of the coloboma is tucked into the anterior chamber away from the wound. This mode of performing iridectomy is different to that in which it is carried out for other purposes, and is best described, for distinction, by the name of iridectomy-dialysis.

The *after-treatment* consists in the firm application of a compress of antiseptic wool with a roller bandage, and keeping the patient in bed until the anterior chamber has re-formed. The shock of the operation on one eye for glaucoma is liable to excite an acute attack of glaucoma in the fellow-eye. To prevent this, eserin drops should always be applied to the fellow-eye on the completion of the operation, and their use continued for a week afterward.

The most fatal and dreaded complication after iridectomy for glaucoma is intra-ocular hemorrhage. As the result of the increased tension the walls of the intra-ocular vessels become altered and brittle; then on sudden diminution of pressure they may easily rupture. The hemorrhage usually takes place between the choroid and sclerotic, and the lens and vitreous may be forced out through the wound.

To prevent intra-ocular hemorrhage, any sudden escape of aqueous must be avoided, all stages of the operation must be performed with deliberation, and the compress afterward be firmly applied.

Suppuration after iridectomy is an exceedingly rare occurrence. The formation of cataract occasionally occurs, sometimes from a wound of the lens during the operation, at other times as the result of adhesion of the upper border of the lens to the sclerocorneal wound, when the anterior chamber has been slow in re-forming. The opacity then commences in the neighborhood of the wound.

For Artificial Pupil.—The direction in which an iridectomy is to be performed for artificial pupil is determined to a large extent by the position of the opacity. When possible, it is best to perform it down and in. The incision should be made with a keratome at or just within the corneal margin; and, as a rule, only a small portion of the pupillary margin of the iris is to be withdrawn and snipped off.

For Closed Pupil from Iritis.—Iridectomy for closed pupil may be a very difficult procedure. The iris becomes so friable and so adherent to the lens-capsule that a satisfactory piece cannot be grasped and drawn out with forceps.

Iridotomy.—Iridotomy is performed when the lens is absent and when the pupil has become closed by an inflammatory membrane. It is most suitable for cases in which, after extraction of cataract as the result of iritis, the coloboma is closed and has become somewhat drawn up. The instruments required are a speculum, toothed fixation-forceps, a broad needle, and iridotomy-scissors.

The operation should be planned so that the cut in the iris is made at right angles to its fibers, which will allow of its gaping afterward. An opening is made in the cornea, a short distance from its margin, with the broad needle, the point of which is carried on so as to make a small hole in the iris. The blades of the scissors are passed through the corneal opening, the sharp-pointed one being directed behind the iris through the hole in it, and the blunt-pointed one in front of it. By one snip the portion of iris and any capsule there may be are cut across and a clear opening is made.

Operations for Cataract.—**Discission.**—In performing the operation of discission the pupil must first be dilated with atropin. The lids can be separated and the globe steadied with the fingers; or a speculum and fixation-forceps may be used. A spear-pointed cataract-needle is passed obliquely through the cornea a short distance from its margin; and with the point a crucial incision is then made in the anterior capsule of the lens. In withdrawing the needle care must be taken to make it pass through the cornea in precisely the same plane that it entered; by so doing a sudden spurting out of the aqueous humor is avoided.

The after-treatment consists in keeping the eye tied up with a compress, and in the application of atropin drops three times a day.

If there was any clear lens-matter present previous to the operation, it will become opaque. Portions of opaque lens-substance will protrude forward into the anterior chamber and gradually become dissolved. In some cases, as the result of a single needling, the lens may become absorbed and the pupil be left black; generally, however, the operation has to be repeated. In some cases the lens-substance, after needling, swells up rapidly, giving rise to pain and increase of tension. A second

operation, either curet-evacuation or suction, must then be performed to let it out.

Curet-evacuation and Suction.—The instruments required for a curet-evacuation are a speculum, toothed fixation-forceps, a narrow keratome, and a curet. The incision is made in the cornea with the keratome, about 2 mm. from its margin. Through this opening the curet is introduced, and with it the lower lip of the wound gently depressed; the lens-matter then escapes along the groove of the curet. Sometimes its evacuation is facilitated by a little counterpressure with the finger on the opposite side of the cornea.

For the suction-operation, either Bowman's hand-apparatus or Teal's mouth-sucker may be employed. The nozzle of the instrument is introduced through the corneal wound into the center of the swollen lens-matter, and then suction is exerted. After either operation care must be taken that no iris or lens-capsule is left entangled in the wound.

The after-treatment is the same as that for discission.

Extraction.—The instruments which should be prepared for extraction of cataract are a speculum, toothed fixation-forceps, a Graefe's knife, iridectomy-forceps, iridectomy-scissors, a cystotome, a curet, a tortoise-shell spoon, and a cataract-scoop.

The incision for extraction of cataract should be made at the corneal margin and extend round about the upper third of its circumference. The speculum is first inserted and the eyeball fixed by grasping the conjunctiva with the forceps below the cornea. The Graefe knife is then passed into the anterior chamber, its point being directed through the sclerocorneal margin toward the center of the pupil. After the point has entered the chamber, it is turned and carried on so as to make a counterpuncture at a corresponding point in the sclerocorneal margin on the opposite side. In completing the incision the knife, as soon as it has penetrated the fibrous-tissue tunic of the globe, should be made to cut a short conjunctival flap. The next stage is to grasp with the forceps and cut off a small piece of iris, not for the purpose of facilitating the exit of the cataract, for it can be easily removed through the unaltered pupil, but to avoid the risk of a subsequent prolapse of iris when the aqueous humor again begins to collect. Some operators prefer not to perform an iridectomy unless the iris shows an undue tendency to prolapse after the cataract has been removed.

The iridectomy having been performed, the cystotome is introduced into the anterior chamber and a T-shaped opening made in the anterior capsule. The cataract is then made to present at, and escape through, the wound by gentle pressure with the tortoise-shell spoon at the lower margin of the cornea. Sometimes a little counterpressure with the curet on the upper lip of the wound assists in its progress out. When the lens is of a sticky consistency, so that, after having presented, it fails to escape easily, its removal may be effected by picking it out with the cystotome. After the hard nucleus has been extracted, the removal of any soft cortical matter that may be left should be attempted by gently stroking the cornea with the curet in the position in which it lies. Finally, the iris at the angles of the coloboma must be tucked back to insure no entanglement of them in the wound.

The after-treatment consists in keeping the patient in bed, with both eyes tied up with compresses of antiseptic wool, for three days. Then the unoperated eye may be liberated and the patient allowed to sit up. Both eyes should be bathed every twenty-four hours with warm boric-acid lotion, and the margins of the lids anointed with a little boric-acid ointment. If there is any complaint of pain or fear of iritis, atropin should be applied. Usually, at the end of a week or ten days the eye operated on can be left untied during the day, but must be kept shaded from any bright light.

Complications.—The most serious complication which may occur during the operation is the escape of vitreous. If vitreous presents before the cataract has been removed, all attempts to extract it by pressure on the globe must be abandoned. The scoop should be passed behind the lens, and then drawn upward with the lens through the wound. Suppuration, should it occur, generally commences at the margin of the wound the second or third day after the operation, and rapidly spreads, involving iris and vitreous humor. As soon as possible after its appearance the infected area should be touched with the galvanocautery, and, if thought necessary, the anterior chamber washed out with chlorin water.

Other complications occasionally occurring after extraction of cataract are intra-ocular hemorrhage, iritis, sympathetic ophthalmitis, and glaucoma. In quite a third of the cases of cataract-extraction a subsequent needling of the capsule of the lens is required. Sometimes cortical matter is left behind in the capsule, and requires exposure to the aqueous to enable it to become absorbed; at other times the clear capsule is much wrinkled and interferes with distinct vision, so that it requires to be torn through.

Operations for Strabismus.—Tenotomy.—The instruments required for tenotomy of one of the recti muscles are a speculum, toothed fixation-forceps, blunt-pointed scissors, and a strabismus-hook.

Before a strabismus-hook can be passed beneath the tendon of one of the recti muscles, an opening has to be made in the conjunctiva and Tenon's capsule. In Graefe's operation this is effected by picking up a fold of conjunctiva with forceps directly over the insertion of the tendon of the muscle to be divided, making a small transverse snip into it with scissors, and then burrowing and snipping with the scissors a little downward in the subconjunctival tissue. The hook is passed beneath the lower border of the tendon, which is cut through close to its insertion. By a free division of Tenon's capsule above and below the muscle, and a free separation of the conjunctiva from it, the amount of retraction of the tendon and effect of the operation can be increased.

In Critchett's operation a fold of conjunctiva, sometimes together with Tenon's capsule, is picked up and snipped into at the lower margin of the insertion of the muscle to be divided. If only the conjunctiva is opened with the first snip, Tenon's capsule has to be picked up afterward and opened separately. The strabismus-hook is next passed into the wound, which is held open with forceps, its point at first being directed backward, and afterward turned upward. It is then drawn forward in contact with the sclerotic, between it and the tendon, until it is arrested by the insertion of that structure. The scissors are

introduced into the wound between the hook and the sclerotic, one blade being passed in front of and the other behind the tendon. With a few snips the tendon is then cut through. The hook should be passed a second or a third time, as may be necessary, to see that no strands of tendon have been left undivided.

After-treatment.—After tenotomy the eye need not be kept tied up more than twelve hours. It should be bathed three times a day with boric-acid lotion. If the effect of the operation is less than was desired, the patient should be directed to look several times a day as far as possible away from the side on which the operation was performed, so as to stretch the newly formed adhesions of the tendon.

Complication.—After tenotomy of the internal rectus muscle a certain amount of sinking of the caruncle almost always occurs; not usually, however, sufficient to be noticeable to other than a skilled observer. Should an excessive amount of sinking of the caruncle seem likely, a stitch should be inserted in the conjunctival wound. Suppuration of the wound is an exceedingly rare event after tenotomy, and should never occur if proper antiseptic precautions be taken.

Perforation of the sclerotic is an accident that has sometimes happened; but it is not likely to occur if a blunt-hook and blunt-pointed scissors are used.

Advancement.—The instruments required for advancement are the same as those for tenotomy, together with a needle-holder, and three small curved needles threaded with fine silk sutures. The first stitch is inserted into the conjunctiva close to the corneal margin and opposite the center of the tendon of the muscle to be advanced. An incision is made through the conjunctiva over the tendon with the scissors, Tenon's capsule is opened, and the strabismus-hook passed beneath the tendon. A second stitch is passed through the upper border of the tendon, and a third through the lower border. The tendon is then divided and held forward while the first middle stitch is passed through the tendon and conjunctiva overlying it, as far back as may be thought necessary.

The upper and lower stitches are passed respectively beneath the conjunctiva above and below the cornea to a point opposite the center of it. A tenotomy of the antagonistic muscle is generally performed before the stitches are tied, during which latter process the eye should be rotated toward the muscle to be advanced. After the operation both eyes should be kept tied up for three days, and the sutures be removed at the end of a week.

Enucleation of the Eyeball.—The instruments required for enucleation of the eye are a speculum, toothed fixation-forceps, blunt-pointed scissors curved on the flat, and a strabismus-hook.

The conjunctiva is first cut as close as possible round the margin of the cornea. Tenon's capsule then being opened, the tendon of each rectus muscle is picked up on the hook and divided close to the globe. After division of the recti muscles the eyeball can be made to protrude by pressing the speculum backward behind its equator. If there has been a perforation and the eyeball is collapsed, it must be drawn forward with the forceps, one blade being passed into the globe to secure a firm hold. The globe being made to protrude, the scissors

are passed behind it, the blades partially separated, and the optic nerve felt for and divided. The eyeball is then further drawn forward, and any other tissues adhering to it cut through.

After-treatment.—Immediately after the operation, a compress composed of antiseptic gauze and wool should be firmly applied with a roller bandage. The hemorrhage after enucleation can always be controlled by pressure. If there is any purulent discharge from the conjunctiva, or if there has been any escape of purulent matter from the eyeball into the wound during the operation, both conjunctival sac and wound should be thoroughly irrigated with mercury-perchlorid lotion, 1 : 3000.

Complications.—Not uncommonly, a few weeks after enucleation of the eye a small mass of granulation-tissue forms at the bottom of the conjunctival sac; it can be easily snipped off, and after its complete removal does not again re-form.

Fatal meningitis has in a few cases been known to follow the removal of eyes with suppurative panophthalmitis. To avoid the risk of meningitis, it has been suggested that suppurating eyes should always be eviscerated. It yet remains to be proved that this operation is less likely to give rise to danger than enucleation.

Evisceration of the Eyeball.—The operation of evisceration, besides being performed on suppurating eyes to avoid the risk of meningitis, is also done sometimes instead of enucleation, in order to obtain a better stump for the artificial eye to rest on. In what is known as Mules's operation, a hollow glass globe is sewed into the sclerotic, after removal of the contents of the eyeball. The instruments required for this operation are a speculum, toothed fixation-forceps, a Beer knife, curved scissors, a sharp scoop, a needle-holder, curved needles with silk sutures, hollow glass globes of various sizes, and an apparatus for the introduction of the latter into the sclerotic.

The cornea is removed by cutting round it with the Beer knife a little outside the sclerocorneal margin. The incision is continued into the sclerotic on each side for a short distance, so that the edges of the wound may afterward come easily together. The whole contents of the globe are scooped out of the sclerotic, great care being taken to remove every bit of the uveal tract. The cavity of the sclerotic is well irrigated with cold mercury-perchlorid lotion, by which means the hemorrhage is soon sufficiently arrested. A glass globe which will fit easily is then introduced, and the edges of the wound united over it, the sutures being passed through both conjunctiva and sclerotic.

After-treatment.—This operation is usually followed by a considerable amount of reaction, general and local. The conjunctiva and lids become swollen, the temperature rises, and sometimes there is vomiting. The amount of reaction can be reduced by the constant application of ice-compresses for the first twenty-four hours after the operation.

Operations on the Eyelids.—**For Entropion or Trichiasis.**—Of the numerous operations for entropion of the upper lid which have been invented, the following modification of Arlt's is most generally useful. The instruments required for it are Desmarre's lid-clamp, a Beer knife, fine dissecting-forceps, a needle-holder, three curved

needles with silk sutures, and a pair of scissors. The clamp having been fixed on the lid, an incision is made with the Beer knife along its free margin, so as to split the tarsus throughout its whole length. The surgeon should endeavor to make the incision pass between the ducts of the Meibomian glands and the hair-follicles, particular care being taken that no hair-follicle is left in the hindermost division. A strip of skin is next removed parallel with, and about 2 mm. distant from, the margin of the lid. Then, by uniting the edges of the skin wound with three sutures, the lashes are everted away from the eyeball. The amount of effect produced can be regulated by the depth of the first incision and the width of the piece of skin removed. In spasmodic entropion of the lower lid the cicatrization resulting from removal of a piece of skin and orbicularis muscle will almost always effect a cure. A piece of the skin should be picked up with a T-shaped pair of forceps and cut off with straight scissors. Afterward a piece of orbicularis muscle is picked up and snipped off in the same way, and the wound is left to heal without the insertion of any sutures.

For Ectropion.—The operation which should be performed for ectropion depends on the amount of the defect. In a case of eversion of the lower lid following marginal blepharitis, the insertion of one or more sutures in the way suggested by Snellen usually suffices. A silk stitch is required, threaded with curved needles at both ends. The two needles are entered a short distance apart at the highest point of the everted mucous surface. After penetrating the conjunctiva and tarsus, they are carried beneath the skin to a point on a level with the lower margin of the orbit, where they are made to emerge. On being drawn upon, the loop of silk left on the everted portion tends to bend the tarsus inward; when sufficient inversion has been produced, the stitches should be tied over a small piece of drainage-tube.

In cases of ectropion of the lower lid in which there has been loss of skin, what is known as the V Y-operation is often very useful. The principle of it is to make a V-shaped flap which will slide up so as to raise the lid; afterward, to draw together the two edges of the raw surface left below the apex of the flap, and convert what was originally a V-shaped wound into a Y-shaped one.

In more extensive cases of ectropion of the lower lid, and in most cases of ectropion of the upper lid, after an incision has been made so that the edges of the lids come easily together and can be temporarily united by sutures, a large raw surface is left. This has to be filled up with a flap of skin taken from some other part of the body. Sometimes one can be twisted round from the temple, a pedicle of attachment being retained. In other cases a totally detached piece of skin has to be taken from the arm. Quite large pieces can be successfully transplanted in this way if they are retained in position without sutures being inserted into them.

Operations for Epiphora, or Lacrimal Obstruction.—The lower canaliculus is the one generally selected to be slit in cases of epiphora, or lacrimal obstruction. Weber's probe-pointed knife is the best instrument with which to perform the operation. The lid is drawn away from the globe and the probe-point inserted into the puncta, the knife being slid along the canaliculus until it is arrested by the inner

wall of the lacrimal groove. The canaliculus being then put on the stretch, and fixed by drawing the lid slightly outward, is slit up along its inner wall by raising the knife into a vertical position.

Small probes can be passed through the unopened canaliculus for the purpose of exploring the lacrimal duct. The puncta, if very small, may be dilated for this purpose with a tapering drill. For the dilatation of a stricture of the duct with large probes the canaliculus must be opened up.

To pass a lacrimal probe, the instrument is held first horizontally and slid along the canaliculus through the lacrimal sac until the inner bony wall is felt. It is then raised to the vertical position and pressed firmly but gently downward, with a slight inclination backward and outward to the floor of the nose.

It is sometimes necessary to incise a stricture in the lacrimal duct. This is best done with a Stilling's knife, which is passed through the canaliculus, after it has been slit, into the lacrimal sac, and down the duct in the same direction as the probe.

CHAPTER XXVIII.

SURGERY OF THE EAR.

DISEASES OF THE AURICLE.

Malformations of the auricle are due to arrest of development, excess of development, or malposition.

Arrest of Development.—*Complete absence* of the auricle is very rare. Partial defects (*microtia*), in which the auricle appears as a shapeless round mass, or rolled upon itself, or with the helix adherent to the tragus, are occasionally seen. *Congenital fistula* (fistula auris congenita) is quite common, appearing as a fistula from 0.5 to 1.5 cm. (0.2 to 0.6 inch) long, leading obliquely inward more or less parallel in the meatus, and secreting a yellowish-white fluid, which, from retention, may form a fluctuating tumor. These fistulæ are almost always situated from 1 to 2 cm. (0.4 to 0.8 inch) above and in front of the tragus; although exceptionally they have been found in the antitragus, lobule, crus helicis, and behind the ear. They are generally referred to an incomplete closure of the first branchial cleft of the fetus; but His considers them due to incomplete union of the crus helicis and crus supratragicus.

FIG. 419.—Microtia (Schwartze).

Excess of development is seen as abnormally large auricles, otherwise well formed (*macrotia*); or as auricular appendages, small projecting masses near the auricle, sometimes composed of folds of skin and subcutaneous cellular tissue merely, but often containing irregular bits of cartilage (*polyotia*). Very exceptionally, excessive development is seen as a *duplication* of the auricle, a more or less well-formed auricle being situated on the neck, a short distance below the natural organ.

Treatment.—In *microtia*, plastic surgery is rarely able to effect anything, the congenital malformation is so great.

Congenital fistula does not call for surgical interference except when there is retention of secretion with the formation of a tumor, or when the secretion is so abundant as seriously to inconvenience the patient. In either case the entire epithelial lining of the fistula must be dissected out or otherwise extirpated; for if this is not done, there is certain to be a re-forming of the tract.

For Macrotia.—Where cosmetic effect demands an operation, Schwartze has obtained a good result by removing a long elliptical piece of the entire thickness of the cartilage, with the skin from the fossa of the helix, then taking out a triangular piece from the helix well into the concha, and uniting the edges by transfixing sutures

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Auricular appendages are readily removed by an elliptical incision around their bases, cutting them off a little below the surrounding surface, and then suturing the skin.

Malposition is seen as an auricle attached at such an obtuse angle to the head as to make it too prominent. To correct this, it is necessary to bind the ear to the skull, which can be done by the operation described by Monks,[1] which consists in dissecting off an elliptical piece of skin embracing both the posterior surface of the auricle and the

FIGS. 420, 421.—Malposition of the auricle before operation and about a year after operation (Monks).

mastoid. The cartilage is then stitched to the head by one or two buried catgut sutures, the edges of the skin united by silk sutures, and a pressure-bandage applied. Judgment must be used in deciding in each individual case how much of the skin should be removed. When the cartilage of the skin is particularly thick, it should be reduced in thickness by paring it down with a knife to diminish its resistance, and care should be taken to retain the natural depression of the antihelix and concha by paring and suturing if necessary.

Wounds of the auricle usually heal well; but if they involve the orifice of the meatus, they are liable to cause stenosis or atresia, which must be guarded against by packing, cauterization of redundant granulations, grafting of skin, or by the insertion of a small flap of skin.

Fissure (*coloboma*) of any portion of the auricle may be congenital, in which case the cartilage is apt to be very thin on the edges of the fissure; or it may be acquired from injury and non-union of the severed edges. The most common form is in the lobule only, due to heavy

FIG. 422.—Operation for coloboma of the lobule.

ear-rings that have slowly cut their way out. All varieties are cured by freshening the edges of the fistula and bringing them together by

[1] *Boston Med. and Surg. Journal*, Jan. 22, 1891.

transfixing sutures. If, however, only this is done, there is apt to be left a small disfiguring notch at the edge when the parts heal, which can be avoided by making a small flap of skin on the edge, and, after the transfixing sutures are applied, stitching this skin across the wound and for a short distance beyond it, freshening the edge for the purpose.

Othematoma (*hematoma auris*) is a bluish-red, fluctuating swelling, usually on the concavity of the auricle, of any size from that of a filbert to involvement of the entire auricle, and is produced by an effusion of blood between the perichondrium and cartilage. It appears in two varieties, spontaneous and traumatic, which differ much in their course and their results.

Othematoma spontaneum occurs usually in the insane, undoubtedly without any appreciable preceding violence ; but also, very exceptionally, without mental disease. Of 620 mentally diseased examined by Kindl,[1] 36 showed the disease or its results : 6 of these suffered from mania, 3 from delusions, 3 from melancholia, and 24 from imbecility. The pathological changes predisposing to the disease are enchondromatous degeneration and atheromatous disease of the vessels. The tumor appears suddenly, sometimes with inflammatory symptoms, reaches its full size within a few days, and then usually undergoes a slow absorption and organization, which finally, after months, leaves the auricle enormously thickened and distorted, or crumpled into an irregular, shapeless mass. Often bits of cartilage can be felt adhering to the walls of the recent tumor.

Othematoma traumaticum is the result of a blow upon the ear. It is quite common in boxers and football-players ; is the effect of direct violence on the healthy ear ; but I have sometimes been able to feel an irregular bit of cartilage in the wall of the tumor, as if the cartilage had split or broken. If left to itself, the fluid is absorbed ; but a certain amount of organization takes place, leaving thickening. I have never seen crumpling of the cartilage from the traumatic variety.

Treatment.—In both varieties the fluid blood should be evacuated with thorough aseptic precautions, and a pressure-bandage, with compresses, applied to keep the walls in firm contact. If the tumor is of only a few days' standing, evacuation by subcutaneous puncture with a small cannula may be done ; if of longer duration, and if coagulation has taken place, an incision will be best. Union of the perichondrium and the cartilage is often slow in forming—in the traumatic variety, from one to three weeks ; in the spontaneous variety, very much longer. When it has taken place, massage is of value in assisting absorption of the thickening.

Fibroma (*cicatricial keloid*) develops in the lobule around the puncture for an ear-ring ; and it may be of any size up to a hen's egg. Histologically, it shows the same structure as a cicatrix of the skin ; but unless removed thoroughly, it will recur. It should be removed by taking out a triangular piece of the lobule in healthy tissue outside of the tumor. The lobule should be pierced well above the growth, and incision made downward in sound tissue. From the original point an incision is now made outward on the opposite side of the tumor, and the two cut surfaces united by transfixing sutures, care being taken that every portion of the growth is thoroughly removed. The operation can be made absolutely bloodless by enclosing the lobule in a large-size Snellen clamp. If the tumor is small, requiring the removal of but a portion of the lobule, the contour of the ear will be better preserved by carrying a narrow flap of skin, with some of its underlying tissue, across the wound, as described under Fissured Lobule.

[1] Inaug. Dissert., Leipsig, 1867.

Angioma is not uncommon, and varies in size from a small superficial enlargement of the capillaries up to a large cirsoid aneurysm involving the whole auricle and its neighborhood, and composed of vessels more than $\frac{1}{4}$ inch in diameter.

These large growths are sometimes fatal from hemorrhage due to rupture of one of the blood-vessels. This occurred in a case of Yüngkens, seven years after he had ligated the common carotid artery to prevent a similar hemorrhage which was threatening at the time of operation; and the same danger was certainly imminent in a case of my own.[1] In these large aneurysmal growths subjective noises are a cause of great discomfort.

The **treatment** of angioma must vary according to the size and character of the tumor. In the smaller superficial forms the thermocautery has given good results; but dissecting off the involved skin is more rapid and certain. In the larger forms electropuncture with the constant galvanic current has been successful. When, however, the whole auricle is involved, amputation of the whole by slow dissection, ligating the vessels as they are severed, is the only resource; and if there is free communication with the arterial system, as is usual in these extreme cases, the common carotid artery must be ligated before beginning the dissection.

Epithelioma is most common on the anterior surface of the cartilage; but is sometimes confined to the lobule.

It is a disease of later life, beginning as a small nodule or superficial ulceration, and extending sometimes very slowly, sometimes rapidly. It is usually superficial for a long time; and I have seen one of fifteen years' duration which had extended from the auricle to the scalp over a surface as large as the palm of the hand, without involving any deeper parts. On the other hand, I have recently seen one which pierced the lobule within one month from the appearance of a small nodule. The degree of malignancy varies very much: I have removed the whole auricle for a small superficial epithelioma without any appreciable infiltration around it, and had it recur in a diffuse form in the parotid region within two months; while I have followed other cases for ten or twelve years after amputation of the auricle, without any sign of recurrence.

Pain is not a characteristic of the disease; when present, it is described as a slight pricking. The diagnosis must be based on the persistent loss of tissue and on microscopical examination of a fragment; everted edges and abundant new tissue are commonly wanting.

Amputation is the only **treatment** to be considered. If but a small surface is involved, removal of the whole thickness of the cartilage well away from the diseased region may be sufficient; and this

FIG. 423.—Atheroma of posterior surface of auricle (Gruber).

may sometimes be done in such a way that the severed edges can be united; but if the cartilage is extensively affected, amputation of the entire auricle is advisable.

[1] Green and Mixter, *Archives of Otology.*

In case the meatus is involved, the entire cartilage down to its insertion on the osseous meatus should be included; and it is then necessary to turn in a flap of skin, preferably from the mastoid, to line at least one side of the meatus, in order to prevent atresia. Unless actually diseased, the tragus may be left to serve as a partial support to an artificial auricle, which is desired by some patients. A small, isolated, recurrent growth justifies a second operation; but a diffuse infiltration, as is usual in the parotid region, is beyond surgical relief, and is commonly fatal in a few months.

Milium, comedo, atheroma, chondroma, lipoma, sarcoma, and gumma are great rarities on the auricle. **Cornu** is occasionally seen: a notable one from the helix, 3 inches in length and coiled upon itself by two revolutions, was proudly exhibited here some years ago by its possessor, who refused to part with it. Cornu can be readily removed by excision of the entire part to which it is attached. **Dermoid cysts,** remnants of the first branchial cleft of the fetus, are occasionally seen in the immediate neighborhood of the auricle; they require removal of the whole cyst-wall. **Sebaceous cysts** are not infrequent on the lobule, especially on its posterior aspect: the entire cyst-wall should be dissected out.

Perichondritis is extremely rare in either the traumatic or spontaneous variety: it simulates somewhat an othematoma, but is destitute of the bluish color, and begins usually in the meatus, extending thence over the auricle.

The secreted fluid from the perichondrium is at first clear, and later purulent. The acute disease is slow in healing, often requiring two to three months; but it may pass into a chronic stage, with constant pain, fistulous tracts, and gravitation-abscesses in the vicinity, lasting two years or more.

In the beginning, compression to promote absorption, by means of collodion, is advised; but if fluctuation is present, free incision, with drainage, is necessary. A certain amount of thickening of the cartilage remains, which may cause partial stenosis of the meatus.

DISEASES OF THE MEATUS.

Malformations.—**Atresia** may be congenital or acquired. When *congenital*, it is usually associated with malformations of the auricle, tympanum, and labyrinth; but exceptionally the auricle is well developed. Atresia is referred to defective development in the first branchial cleft, leaving defects in the drum-membrane and tympanic ring, osseous obliteration of the tympanum, and often also of the labyrinth, together with closure of the meatus, either osseous or membranous. On account of these accompanying malformations in the middle and inner ears a restoration of the meatus, even if possible, can in most cases accomplish nothing for the hearing, and an operation is only permissible when the Weber test with the tuning-fork is localized in the affected ear, and when at the same time the atresia is simply membranous.

Acquired atresia is due to the fusion of granulation-tissue across the passage which has undergone fibrous organization, the granulations being the result of either trauma or inflammation. In these cases the obstructing tissue may be very thin or it may obliterate the entire meatus.

Treatment.—In either variety, if acupuncture shows that the membrane is not more than ¼ inch in thickness, it may be excised by a circular incision near its periphery; or quartered by two cross-cuts, and the triangular flaps excised by curved scissors, the opening being retained by keeping a rubber or metallic tube in the meatus until the epidermis has formed over the wound. A better method still is by

inserting a bit of skin from the concha or tragus by means of a plastic operation.

Secretion Anomalies.—The perspiratory and sebaceous glands of the meatus secrete the cerumen, which, when exuded into the ear-passage, dries in small scales and drops out or is brought away by constant growth and outward movement of the epidermis. From hyperproduction due to congestive conditions of the skin or from accidental causes interfering with its natural removal, the secretion often collects in such masses as to require artificial removal. The symptoms vary, depending on the partial or complete closure of the meatus and pressure on the drum-membrane. If there is but partial closing of the passage, there is a slight feeling of fulness and inter-mittent closure, due to the wax-covered walls adhering together from any pressure upon the ear, as in lying upon it, or from the mass swell-ing when water accidentally enters. If the closure is air-tight, there is great loss of hearing by air-conduction, a feeling of fulness, often subjective noises, and occasionally resonance of the patient's voice in that ear (*autophony*). If the closure is air-tight and the mass presses upon the drum-membrane, there may be vertigo from intralabyrinthine pressure, and even vomiting and convulsions. Long-continued press-ure of a large mass, which becomes harder and harder from the dry-ing out of its watery constituents, may produce inflammation of the skin, with pain, sensitiveness on pressure, suppuration, and granu-lations.

The **diagnosis** is made by inspection, the obstructing mass being distinctly visible by the reflecting-mirror.

Treatment.—Removal can be effected in all cases by the syringe; but if the collection is very hard, it had better be softened first by the instillation of a mixture of glycerin and water and sodic bicarbonate, which should be retained in the ear for half an hour, with the patient in a reclining position. After such softening, the removal by the syringe can be very much facilitated by making a small opening through the mass by means of a probe passed along the anterior wall of the meatus.

Inflammation.—**Furunculosis** (*otitis externa follicularis*) is an infection of the hair-follicles of the meatus by the common pyogenic microbes, chiefly Staphylococcus albus and aureus, which, deposited in the base of the follicle, between the hair-bulb and its sheath, under favorable conditions develop a suppuration. This in most cases extends outward, involves the connecting sebaceous gland, and finally ruptures on the surface; but exceptionally the pus burrows in the subcutaneous cellular tissue, even forming an external abscess behind the auricle. Auto-infection from one follicle to another is very com-mon, and explains the succession of furuncles at intervals of a few days with which some persons suffer for months.

The disease is sometimes epidemic; and it may also be secondary to a purulent inflammation of the tympanum.

The situation and size of the inflamed area explain the subjective symptoms: if situated at the orifice of the meatus, where there is room for swelling without pressure on the sensitive nerves, the pain is very slight; if within the meatus, the pain is often severe. If the swelling

is great enough to close the meatus, deafness, subjective noises, and throbbing are present. If the swelling is on the anterior lower wall, movement of the jaw is distressing. In all cases movement of the cartilage is painful; and this is the chief diagnostic symptom, being of special value in the beginning, before the swelling has become marked. After the second or third day inspection shows a circumscribed swelling, usually with a reddened cutis; and the exact seat of the follicle can be determined by sensitiveness on pressure with a probe.

Differentiation from mastoiditis with periostitis of the meatus is made by the circumscribed character of the swelling, its sensitiveness, and the short duration of the symptoms in furuncle compared with the diffuse swelling in the upper posterior wall only, absence of sensitiveness, the longer and severer character of the symptoms, and usually the sensitiveness of the bone itself on deep pressure that are seen in mastoiditis.

Treatment.—In the beginning, when there are only slight pain and sensitiveness of the cartilage, without visible localized swelling, the application of dry heat will relieve the pain; and many such cases abort and come to nothing. As soon as swelling appears, a cotton pledget soaked in warm carbolic acid and glycerin (1 : 30) should be inserted into the meatus, and the ear kept warm by dry heat or by wrapping in cotton. The pledget of cotton should be changed three or four times a day. If the pain is severe, an opiate or phenacetin may be necessary at night. As soon as fluctuation can be detected— and, in my opinion, not earlier—a free incision should be made through the most projecting point of the swelling, the cavity emptied by gentle pressure, the meatus cleansed by wiping with corrosive sublimate (1 : 3000), and a carbolic pledget inserted as before. This cleansing should be repeated daily until suppuration ceases and the wound closes. The patient should then be instructed to paint the meatus twice a day with a saturated solution of boric acid in absolute alcohol for two weeks, to try to prevent recurrence. In some cases a firm induration wholly or partially closes the meatus after the acute disease is past, and pressure with a dry cotton pledget assists absorption and restoration of the canal. Granulations at the seat of the wound may require removal or cauterization with argentic nitrate.

Diffuse inflammation of the meatus (*otitis externa diffusa*) as a primary disease is very rare; but as a secondary complication of suppuration of the tympanum, it is occasionally seen in adults, but oftener in children; it is occasionally seen in children during scarlet fever, measles, and erysipelas, without preceding disease of the tympanum. As its name expresses, it is an inflammation of the walls of the ear-passage, at first usually of the osseous meatus, beginning with hyperemia, slight swelling, and serous discharge, followed by loss of the epidermis and suppuration of the entire surface, which in a case of some duration is often changed into small granulations from hypertrophy of the papillæ. If severe, it may assume in the osseous meatus the characteristics of a periostitis, with loosening of the periosteum and pus next the bone. Through the fissures of Santorini in the cartilaginous meatus or defective ossification of the meatus in children, the inflammation may extend to the parotid region. Redness

and edema over the mastoid may also be present. The congestion and edema usually extend to the drum-membrane, obscuring and often concealing the short process and manubrium, and producing more or less deafness and subjective noises; and perforation of the membrane from without inward by ulceration may take place.

Symptoms.—In the earliest stages the pain is severe and any movement of the meatus painful; but with the establishment of suppuration the pain ceases. Inspection shows the meatus red, slightly and irregularly swollen in all its walls, especially in the osseous portion, and the line of demarcation between the meatus and drum-membrane obliterated; when the epidermis has been destroyed a granular bleeding surface is frequently seen over the entire meatus. The disease may become chronic and continue for months, with polypoid growths, which may fuse together and partially or wholly close the meatus, with extensive desquamation of epidermis, with great thickening of the cutis of the drum-membrane, or with perforation and more or less destruction of that membrane.

Treatment.—In the beginning, one of the most effective agents for relief of the pain is the application of from 1 to 3 leeches to the tragus and lower edge of the orifice of the meatus, protecting the wounds from the secretion by a collodion dressing. Later, when the secretion has become purulent, thorough cleansing by syringing with corrosive-sublimate solution, (1 : 5000), drying carefully with absorbent cotton, and then inserting a pledget of cotton soaked in carbolic acid and glycerin (1 : 50), will be sufficient usually. The syringing is to be done often enough to keep the passages fairly free from pus—once, twice, or three times a day; and the pledget is to be renewed at least twice a day. Polypoid growths require removal with the snare; small granulations should be destroyed by a bead of argentic nitrate fused on a probe. Contractions of the canal, if recent, can be reduced by pressure with a dry cotton pledget after secretion has ceased; if old and firm they may require systematic and long-continued pressure by means of compressed sponge or laminaria. If, however, the disease is secondary to suppuration of the tympanum, the above treatment must be modified so as not to expose the patient to the risks of retained pus. In these cases the otitis externa is almost always due to imperfect and insufficient cleansing of the tympanum and meatus, and attention should be directed to this particularly, and the applications of the medicated pledget should be for only a few hours at a time and intermittently.

Otomycosis.—Vegetable parasites—aspergillus, ascophora, tricothecium, mucor—are not uncommon in the meatus. It is rare for any of them to produce any symptoms except Aspergillus flavus or niger; with this there is often a mild but obstinate diffuse inflammation of the skin, with serous discharge, moderate pain, and intense itching. The filaments of the plant appear as a whitish layer on the surface, and the erect fruit-heads, black or yellow, project into the meatus : in doubtful cases the microscope will settle the diagnosis. The persistency of the disease is due to the penetration of the mycelium of the plant into the tissues. Removal of the growth with forceps, and persistent instillations and painting with alcohol, at first diluted (50 per cent.), and, when the inflammation has subsided, pure (95 per cent.), will effect a cure.

Fracture of the meatus may result from blows on the chin, which, transmitted through the lower jaw, fracture the anterior wall

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which forms part of the glenoid fossa. I have seen 1 such case from a blow on the point of the chin, in which the anterior walls of both meatuses were driven in symmetrically on the two sides so as to close the passages about one-half. No attempt was made to replace the bone, and the case recovered, with perfect movement of the jaw.

Similar cases have been reported by Schwartze[1] and Beach,[2] and a case is reported by Boyer, in which the condyle of the lower jaw was driven through the meatus into the middle fossa of the skull.

Occasionally, fractures of the base of the skull through the tympanic roof extend into the meatus.

Once I saw a fracture of the lower half of the mastoid from a direct blow on the mastoid, in which a displaced fragment of bone protruded through the skin of the posterior wall; this case also recovered perfectly under aseptic dressing.

Exostoses (*osteomata*) are not uncommon in the meatus, occurring as round or oval growths covered with normal cutis, generally with a broad base, but occasionally small, with a distinct pedicle.

FIG. 424.—Exostoses of the meatus (Welcker).

They are composed usually of ivory-like bone, but exceptionally are spongy in their interior. They are usually of very slow but continuous growth. Their situation is either in the outer third of the osseous meatus or at the edge of the pars tympanica, spots where, in developing, the osseous meatus fuses with the mastoid posteriorly and with the glenoid fossa anteriorly, or where the pars tympanica unites with the petrous bone. This fact suggests, as Virchow says, that they are due to irritative disturbances of the normal osseous development. They are often symmetrical on the anterior and posterior walls; often symmetrical in the two ears. The small, round pedunculated, variety is always found close to the tympanic ring on the upper wall.

The appearance of a smooth tumor with normal cutis, without inflammatory symptoms of pain and discharge, is often sufficient for the diagnosis; but any doubt is removed by acupuncture with a needle, which demonstrates the osseous character.

Subjective **symptoms** are absent unless the growths close the meatus, when there is a feeling of fulness, deafness, and subjective noises.

A general hyperostosis (osteosclerosis) of the mastoid somewhat simulates in appearance an exostosis of the posterior wall; but it is much more diffuse, with no distinct outline, and is the result of a preceding inflammation, usually, if not always, of a tympanic suppuration, the history of which can be obtained, or signs of which can be seen as cicatrices or calcifications on the drum-membrane.

Treatment.—Surgical interference with exostoses is only necessary when they close the passage, producing deafness; or when there is suppuration behind them in the tympanum and they act as obstructions to evacuation of pus.

If distinctly pedunculated, they can in very exceptional cases be removed by placing a small osteotome against the pedicle and fracturing this by a sharp, short blow with a mallet. If broad-based, the growths should be exposed by deflecting the auricle and cartilaginous meatus forward and downward by an incision beginning at the upper

[1] *Die Chirurgischen Krankheiten des Ohres.*
[2] *Boston Med. and Surg. Journal,* March 2, 1876.

anterior edge of the auricle and carried around the auricle, $\frac{1}{2}$ cm. from its insertion, down to the level of the lower edge of the meatus. The auricle then should be dissected off without the periosteum till the meatus is reached. Next, the periosteum should be incised close to the meatus, above and behind, and separated from the bone, together with the cartilaginous meatus and auricle, till the exostosis is reached. The auricle and meatus can then be drawn downward and forward by a blunt hook, and the exostoses removed by chisels and mallet, or by burrs on a surgical engine. Strict asepsis is, of course, necessary; and when the operation is complete the periosteum should be replaced and retained by absorbent sutures, the auricle stitched into position, a light packing placed in the meatus to retain the periosteum against the bone, and an aseptic dressing applied over the ear and mastoid.

Desquamative Inflammation.—The meatus is subject occasionally to a low form of inflammation of the skin, producing an increased formation of epidermis, which, desquamating, forms large collections, which gradually fill the passage (*keratosis obturans*). The exact etiology of the disease is not known: it sometimes follows otitis externa diffusa, but in many cases there is no history of preceding inflammation. It may involve the entire meatus, or may be circumscribed in any part of it. It is more common in the osseous than in the cartilaginous meatus, and much more common in adults than in children. At first there is a mere collection of scales of epidermis, one upon another; but as the passage becomes filled, there is a slow absorption of the bone or cartilage beneath the mass, and the meatus may be enlarged to twice its natural size, or large cavities may be formed, even to the depth of $\frac{1}{3}$ inch. The irritation of the collection often produces hypertrophy of the papillæ, producing granulations, and the surface becoming infected suppurates, and caries may result. It is unattended by any symptoms except those of closure of the meatus.

Treatment.—In appearance the mass exactly resembles a collection of cerumen, which is often mingled with it; but, if of any size, it resists all attempts at syringing, and must be removed by instruments. The removal is always painful, and often requires etherization. Previous softening is of but little value; the best agent, sodic bicarbonate in water ($1:2$), only penetrating slightly. A probe, or, better still, a small blunt ring, should be passed close along the meatus-wall, and the epidermis next the wall slowly and gradually loosened all around. This should be continued deeper and deeper till the mass is fairly free: it should then be seized in strong, angular, toothed forceps and slowly withdrawn. If the whole mass comes out, its outer surface will be seen to be covered with a white, pearl-like, smooth, glistening membrane, often, when the entire meatus is involved, resembling a finger of a glove, and the appearance of this membrane shows that the whole is removed. Often but a part comes away at first, and the same process must be continued till inspection shows the meatus is clear. If granulations are seen, they should be removed with a wire snare if large, or destroyed by argentic nitrate if small; and the meatus should be painted daily with a solution of boric acid in absolute alcohol (gr. xv ad ℨj) till the epidermis assumes a normal appearance. In many cases there is recurrence, however well the cutis may look; and the ear

should be inspected every four or five months, as it is much less painful to remove a small collection than a large one.

Carcinoma.—Primary epithelioma is very rare: I recall but 1 case which appeared as a polypoid growth from the cartilaginous meatus and recurred rapidly after removal by the snare for diagnostic purposes. The patient refused a radical operation, and lived for twelve years with much suffering, finally dying from extension of the disease to the brain. Other forms of cancer in the meatus are always extensions from neighboring parts, usually from the parotid or mastoid region. Radical extirpation is the only treatment, and this is only possible when the disease is confined to the cartilaginous meatus.

Milium, atheroma, angioma, papilloma, enchondroma, condylomata lata are extremely rare, but have been reported.

Exostosis cartilaginea is an exostosis as yet only found in persons less than twenty-five years of age, covered with cartilage, and either lying loosely in the surrounding bone or attached by a small pedicle.

Of the 4 cases which I reported,[1] the growth originated in the mastoid wall of the meatus in 3, and apparently from the tympanum in 1. They were exposed by displacement of the auricle forward, and then extracted by forceps, without cutting the bone.

Too few cases have as yet been observed for one to speak very positively of them; but they are apparently congenital, and it seems to me probable that they are developed from remnants of fetal cartilage.

Foreign bodies may be animate or inanimate, and may lie loosely in the meatus or be impacted; they may be of such a structure that they will swell from moisture, or they may be impervious to dampness. All of these characteristics are to be considered in attempting removal.

Live insects, if active, often produce great pain from their movements against the drum-membrane, and require immediate attention. They can be readily killed by drowning by letting the patient incline the head, and then filling the meatus with warm water. The insect, then, if small, will often float out; but if it does not, it can be removed by syringing or by the angular forceps under inspection. This method, however, is ineffectual with maggots, which sometimes develop in large numbers in a suppurating ear. With them the instillation of oil is necessary to kill; but the two sharp hooks in the head often remain buried in the flesh, and the worm must be removed by the angular forceps under inspection with the head-mirror, if it is so fixed that it cannot be syringed out. As many as 64 larvæ have been removed from one ear.[2]

Inanimate objects (peas, beans, pebbles, beads, etc.) are not uncommon: the majority of them can be removed by simple syringing, if they have not been impacted by injudicious manipulation; but if they are liable to swell from the moisture, the surgeon should be ready to practise instrumental removal immediately when syringing fails. An inanimate body lying loosely in the meatus is harmless: it may so lie for months without symptoms. Cerumen collects about it, and so closes the passage; there is therefore no immediate urgency with such bodies. When firmly impacted, however, the pressure in the sensitive

[1] *Trans. Amer. Otolog. Soc.*, 1893 and 1894.
[2] Stohr, *Bayr. Intelligenz-Blatt*, 1878.

walls of the meatus may produce inflammation. Injudicious attempts at removal with instruments often produce this impaction, and from injury to the canal set up violent inflammation. The impaction may be at the junction of the cartilaginous and osseous passages (the narrowest spot), in the angle between the lower wall and the drum-membrane, in the drum-membrane itself, or within the tympanum. These impacted bodies can only exceptionally be removed by syringing: instrumental removal is usually necessary, and the ingenuity of the surgeon is often taxed in adapting his instrument to the body and its situation. A great variety of instruments have been suggested: the most generally useful are the small blunt hook, for beads or similar objects; the sharp hook, for peas, beans, and soft substances; the wire loop of a snare, which can sometimes be passed beyond a pebble or similar round substances, and the object thus gradually rolled out; and the angular toothed forceps, for bits of wood or similar objects. In a difficult case the surgeon's armamentarium can scarcely be too large, and a thorough knowledge of the anatomy is necessary. No general rules can be given.

If the meatus is inflamed, or if the case is that of a child or nervous adult, a general anesthetic is necessary.

In exceptional cases removal through the natural meatus is impossible: either from lack of space to exert the necessary leverage; from the foreign body having passed beyond the narrowest part of the meatus, and then having expanded from swelling or other cause; or from its having been impacted deeply in the tympanum. In such cases a displacement forward of the auricle and cartilaginous meatus, as described under exostoses, will permit extraction; for the length of the passage is thus reduced nearly two-thirds, and the deeper meatus and tympanum are very fully exposed. In this way I have successfully removed impacted glass and several flattened bullets from the tympanum, and swollen vegetable substances from the deeper meatus, which it was physically impossible to bring out through the cartilaginous meatus. Inflammation of the meatus, rupture of the drum-membrane, or suppuration of the tympanum may require subsequent treatment.

General Rules.—A foreign body requires removal, as it will eventually cause trouble; but immediate removal is necessary only with live insects. Syringing alone will succeed in a very large proportion of cases; but if the body is liable to swell from moisture, the surgeon should be prepared for immediate instrumental removal in case syringing fails.

DISEASES OF THE TYMPANUM.

Diseases of the tympanum embrace 66.9 per cent. of all aural affections. They are pathological changes of the mucous membrane of an inflammatory nature; but in considering them, it should be remembered that the mucous membrane constitutes the periosteum of that cavity. The histological changes are such as occur in other mucous membranes, and their results upon the ear are due to the fact that the mucous membrane covers the entire chain of the conducting mechanism of the tympanum. The symptoms produced by these changes are

due to interference with the normal physiology of this conducting mechanism.

These tympanic diseases are: 1. Non-infected secretory inflammation (otitis media catarrhalis), characterized by moderate hyperemia of the mucous membrane; moderate swelling from serous and round-cell infiltration; and secretion of serous, mucous, or seromucous fluid on the surface of the mucosa. 2. Infected secretory or suppurative inflammation (otitis media suppurativa vel perforativa), due to pathogenic and pyogenic organisms, and characterized by very great hyperemia, infiltration of serum, leukocytes, and round cells, and secretion of seropurulent, or mucopurulent, or purulent fluid on the free surface of the mucosa. 3. Non-infected hypertrophic or adhesive inflammation (otitis media catarrhalis hypertrophica vel adhesiva), due to the organization of the round-cell infiltration of the mucous membrane into fibrous connective tissue, and characterized by hyperplasia of fibrous tissue. 4. Sclerosis (dry catarrh), essentially an atrophic process, in which the mucous membrane becomes stiff, inelastic, pale, and dry, with obliteration of the blood-vessels and depositions of lime and bone.

The hypertrophic processes are the result of one of the preceding secretory inflammations. Sclerosis may be secondary to, and the result of, preceding secretory inflammations; but in many cases it is undoubtedly a primary disease, the cause of which is not understood.

The true catarrhal inflammations are so much less distinctly surgical than the suppurative inflammations; they require such a special training in otoscopy, testing, and delicate manipulation; and are so intimately connected with diseases of the nasopharynx, that it is impossible to do more than mention them here.

Suppurative inflammation of the tympanum (*otitis media suppurativa vel purulenta vel perforativa*) is due to infection of the tympanum with the pathogenic microbes—Bacillus pneumoniæ (Friedländer), Diplococcus pneumoniæ (Fränkel-Weichselbaum), Klebs-Löffler bacillus; or with the pyogenic microbes—Streptococcus pyogenes, Staphylococcus pyogenes aureus, cereus, or albus, or with the Bacillus pyocyaneus. These enter the tympanum (1) through the Eustachian tube directly from the nasopharynx; (2) from the nasopharynx along the blood- and lymph-vessels, or (3) from the blood itself through the blood-vessels.[1] The first route is the most common.

In the noses and throats of healthy persons microbes, both pathogenic and pyogenic, are constantly present.[2] Investigations have shown that the numbers of these diminish gradually from the nostrils inward; but they have been found at the pharyngeal orifices of the Eustachian tube, and have also been found in healthy tympana. The protection against them lies in the physiological peculiarities of the organism, which peculiarities are general or local. The general ones are: Vital energy of the normal tissues; properties of normal blood which are fatal to bacteria; properties of normal organs to resorb and to produce chemical changes that are fatal to bacteria. The local peculiarities are: Intact condition of the epithelium of the respiratory tract, which prevents the entrance of bacteria into the blood- and lymph-vessels; the ciliated epithelium which lines the respiratory tracts of the nose and nasopharynx and the Eustachian tube, and always moves from within outward; the presence of saprophytic and other fungi, which, by their chemical products, diminish or destroy the virulence of the pathogenic microbes. Any change in the organism, either general or local, may produce a change in the relation of these protective factors, and the parasites thus find conditions favorable to their development and multiplication. It is

[1] Zaufal.   [2] Besser's tables.

claimed by Haug that the specific virus of a general disease, either bacillar or non-bacillar, may find its local expression in a tympanic suppuration due to the deposition of the specific virus in the tympanum.

In 101 cultures made from the first drop of pus evacuated after paracentesis in acute suppuration, and examined in the laboratories of the Boston City Hospital and Massachusetts Charitable Eye and Ear Infirmary, the results were as follows : Pneumococcus (Micrococcus lanceolatus) alone, 10 ; with staphylococcus, 4. Streptococcus alone, 19 ; with Staphylococcus aureus, 11 ; with albus, 2. Staphylococcus albus alone, 8 ; with streptococcus, 2 ; with Bacillus diphtheriæ (Klebs-Loffler), 2. Staphylococcus aureus alone, 9 ; with streptococcus, 11 ; with Bacillus diphtheriæ, 2. Bacillus diphtheriæ alone, 2 ; with Staphylococcus albus, 2 ; with aureus, 1 ; with a capsule-bacillus, 2. Staphylococcus (variety not stated), 19 ; with pyocyaneus, 1 ; with Pneumococcus, 4. Bacillus pyocyaneus alone, 3 ; with staphylococcus, 1. A capsule-bacillus, 3. In 4 cases there was no growth. These statistics give as the predominating growth pneumococcus in 14, streptococcus in 32, staphylococcus in 38, Bacillus diphtheriæ in 7, pyocyaneus in 3.

Acute suppurative inflammation of the tympanum may be produced by any hyperemic condition of the nasopharynx, such as occurs with coryza, adenoids, tonsillitis, diphtheria, syphilis; by the exanthematous fevers—scarlatina, measles, small-pox, typhoid, and typhus; by pneumonia, influenza, erysipelas; or by traumatism from punctures of the drum-membrane. It usually involves the whole mucous membrane, including that of the Eustachian tube, drum-membrane, and mastoid cells. It is characterized by extreme hyperemia, followed by a serous infiltration of the tissue which separates the fibrillæ of the connective tissue; then by a free secretion of pus mixed with mucus; and finally by enormous swelling of the tissues from a small-cell infiltration. The ultimate fate of this round-cell infiltration determines the result of the disease on the ear; there may be fatty degeneration and absorption of these cells, with restoration of the membrane to its normal condition; there may be liquefaction of the cells, with resulting ulceration of tissue; there may be organization of the cells and resulting hyperplasia of tissue. The inflammation may extend into the bone, forming a fine-cell infiltration in the osseous lacunæ; and from liquefaction of the cells caries and necrosis may result, and from their organization hyperostosis may result. The inflammation may also extend into the labyrinth, generally along the blood-vessels, with all the characteristics of the original inflammation. Rupture of the drum-membrane, usually from pressure of the secretion, but occasionally from ulceration, is the rule.

As subjective *symptoms*, there occur with the initial swelling and closure of the Eustachian tube a feeling of fulness in the ear; with the increasing hyperemia subjective noises, as of crickets; and, as the vessels dilate, pulsation. The increasing swelling, by pressure on the sensitive nerves, produces pain, both lancinating and dull, usually of an intense character. As the secretion forms, there are increasing fulness and deafness from interference with the conducting mechanism; and finally, with rupture of the drum-membrane, there is discharge into the meatus, with relief to the pain. As an objective symptom, fever is often present, especially in children. The hyperemia is seen on the drum-membrane, beginning with the larger capillaries just behind the manubrium and gradually extending over the entire membrane, which then becomes dull, opaque from serous infiltration, and often dotted with white desquamated epithelium. As the tympanic secretion forms, it gradually bulges the drum-membrane outward, and the rupture

usually occurs at the apex of the bulging. There is deafness, often very great, for aërial conduction; bone-conduction is prolonged, and Weber's test is localized in the affected ear. If the inflammation has extended to the labyrinth, subjective metallic ringing is present, bone-conduction is lost, and Weber's test is then localized in the unaffected ear. Exceptionally, the hyperemia is so intense as to involve the entire petrous bone and fatally infect the meninges of the brain within forty-eight hours from the first symptoms. As the disease almost always affects the entire tympanic mucous membrane, the mastoid is generally involved, and this is shown by sensitiveness of the bone to pressure.

Rupture of the drum-membrane marks the height of the acute process. The established otorrhea usually relieves the pressure, and consequently the pain. The hyperemia subsides; the secretion gradually ceases; the perforation of the drum-membrane heals, either by union of its edges or by a plastic material; the swelling slowly subsides, and thus frees the conducting mechanism; and there is a restoration to the normal. In less favorable cases, as the acute inflammation subsides, instead of restoration of the mucous membrane to its normal thin, elastic condition, hypertrophic or sclerotic processes set in, with resulting permanent injury to the conducting apparatus. In still other cases ulceration of the soft parts occur, with more or less destruction of the drum-membrane, and with ulceration of the bone in any situation, with caries of the ossicles or caries of any portion of the tympanic wall and resulting chronic otorrhea. In other cases a true mastoiditis develops.

Treatment of Acute Suppuration.—Confinement to house, and, when there is fever or other constitutional disturbance, confinement to bed, is necessary. A saline cathartic should be given. Pain is the urgent symptom, to be combated by the local application of dry heat in the form of a hot-water bottle or a baked horseshoe-shaped salt-bag. If seen early, the application of a 2 per cent. solution of cocain to the pharyngeal orifice of the Eustachian tube, either by a cotton applicator through the nostrils or behind the palate, or by allowing 3 or 4 drops to run back into the nostril with the head inclined backward and toward the affected side, will often give considerable ease by relieving the hyperemia and consequent closure of the tube; if this method is successful, it may be repeated several times a day. Morphin is often necessary at night; or, with young children, chloral hydrate. In from twelve to sixty hours the secretion will have formed; and as soon as the drum-membrane bulges, the tympanic cavity should be evacuated and drained. If nature does not do it early by a rupture, then the surgeon should do it by a paracentesis.

should be made as described above ; but exceptionally the secretion presents itself at other spots than the lower posterior quadrant ; for instance, at the upper posterior quadrant, at the lower anterior quadrant, or at the membrana flaccida. In such cases it may be necessary to incise the most protruding portion. In doing this the anatomical relations of the ossicles, the chorda tympani nerve, and the stapedius muscle must be borne in mind, and their structures avoided by the direction of the incision, and by not thrusting the knife in deeply.

The case is now reduced to a suppurating cavity within the bone, opening externally through the drum-membrane ; and this cavity should be kept drained. If the secretion is thin, this can be done by inserting a wick of corrosive-sublimate cotton, loosely rolled, into the deeper meatus, and placing outside, in the concha, a small absorbent pad of the same ; the pad being changed as soon as it becomes saturated, and the wick changed two or three times a day whenever it becomes hard from dried secretion. If the secretion is too thick to be absorbed by the wick, gentle syringing with a weak, warm (102° F.) antiseptic must be used sufficiently often (two to six times a day) to keep the meatus fairly clear. For syringing I prefer the ordinary bulb-syringe (Davidson's), as it is more easily kept clean. Inflation of the ear is to be avoided during the first week ; but after that time Valsalva's or gentle Politzer's inflation may be used with advantage once a day. After cleansing by syringing and inflation, the meatus should be carefully dried, and a very small quantity of finely pulverized boric acid blown into the ear—not enough to obstruct evacuation of any secretion. As the secretion diminishes, applications should be made less often ; and when it has ceased, all treatment should be omitted till the perforation has finally closed, when, if hearing does not return, Politzer's inflation or stimulating vapors by the Eustachian catheter may be used. In favorable cases the tenderness of the mastoid disappears after perforation of the drum-membrane ; if it does not, it is best treated by the application of ice, either by a Leiter's coil or an ice-bag, preferably the former. As a rule, pain soon ceases to be an urgent symptom after perforation of the drum-membrane, and local treatment is all that is required. If pain still continues in more than a slight degree, it is due either to a developing mastoiditis, to involvement of the bone, to extension to the labyrinth, or to a brain-complication.

Extension of the inflammation to the labyrinth may take place along the blood-vessels anastomosing between the vestibule and the tympanum ; though sometimes it may occur by perforation of the membranes covering either the fenestra ovalis or fenestra rotunda ; and still more rarely by carious perforation of the bone. It is characterized by intense pain, by high-pitched metallic ringing, by loss of bone-conduction, and almost always by total deafness. No special treatment can be applied other than that for the tympanum ; and this inflammation usually subsides as the tympanic inflammation subsides, but leaves total deafness from destruction of Corti's organ. Suppuration within the labyrinth has a free communication with the brain along the meatus internus and aqueductus vestibuli, and the possibility of intracranial disease should be remembered in these cases.

Involvement of the bone in acute tympanic suppuration is rare, although it is very common in the chronic variety. When the inflammation is particularly virulent, as in scarlet fever and diphtheria, it occasionally occurs ; and I have found extensive caries of the ossicles within four weeks of the beginning of a suppuration following scarlet fever. These bone-complications, as well as the intracranial complications and true mastoiditis, will be spoken of later.

Chronic Suppuration of the Tympanum.—By failure of nature or art to relieve the acute suppuration, the case passes into the chronic stage, characterized by an open perforation and a persistent purulent

discharge from the tympanic mucous membrane. The suppuration is due to the ordinary pyogenic microbes—streptococcus and staphylococcus—which have supplanted the pathogenic organisms, if such were present at first. The chronic character is due to infected foci of inflammation, which keep up their vegetative activity and continually reinfect other parts. These infected foci may be in inspissated pus or cholesteatomatous masses: they often exist in granulations, and sometimes in the bone; and they may be situated in the tympanum, epitympanum, aditus, antrum, or mastoid. If in the bone, they may be limited to a small spot on the ossicles, or any other circumscribed portion; or they may involve a large part of the temporal bone.

The mucous membrane is usually changed into a thick, edematous cushion, with much new growth of connective tissue, sometimes diffuse, sometimes circumscribed, and forming distinct prominences. Its epithelium is often destroyed, and the entire membrane changed into a granulating connective tissue; the epithelium is often thickened and proliferating (desquamative inflammation). The mucous membrane is often ulcerated, exposing the bone; and the bone itself may be carious to any extent and in any part. In cases of long continuance the mucous membrane, after the loss of its epithelium, may undergo a connective-tissue degeneration, lose entirely its character of mucous membrane, and become changed into cicatricial tissue, which, after suppuration ceases, is liable to the contractions and frequent changes of such tissue. Moreover, a mucous membrane which has undergone this connective-tissue degeneration, become cicatrized, and covered with epithelium, may, when irritated, take on a form of dermatitis, with active proliferation and desquamation (desquamative inflammation); and if the irritation reaches the connective-tissue stratum beneath the epithelium, this stratum proliferates, breaks through the epithelium, and forms granulations.

The perforation of the drum-membrane may be of any size up to a loss of the entire membrane from ulceration of the edges of the original perforation. The last portions to be destroyed are those best nourished, viz., along the posterior edge of the manubrium and the periphery. Any portions remaining are liable to undergo thickening, atrophy, and calcification. A large perforation so diminishes the tension of the membrane that remaining portions are drawn inward—even to the labyrinthine wall—by contraction of the tensor tympani muscle, and may become adherent to this wall.

Subjective symptoms of a simple chronic suppuration are in most cases limited to the discomfort of a continuous otorrhea and more or less deafness. The deafness depends on the condition of the conducting mechanism, and often varies at different times according to the amount of secretion and its position in the tympanum. Weber's test is localized in the affected ear; Rinné's test is negative. Subjective noises are rare; if present, they are due to pressure on the stapes or fenestra rotunda, usually from secretion. Pain is usually wanting, except with exacerbations of inflammation.

Objective symptoms are the discharge and the open perforation, seen on inspection.

The *treatment* consists in getting rid of the infected foci; these may

be in retained secretion, granulations and polypi, caries or necrosis, labyrinthine inflammation, and mastoiditis. Often several of these exist together, as, for instance, retained secretion, granulations, and caries, and must be got rid of one after the other.

Retained secretion is found either as inspissated pus or desquamative products (desquamated epithelium, cholesterin, pus, and detritus—the so-called cholesteatomatous masses). It is most common in the epitympanum, retained by the ligaments of the ossicles and folds of mucous membrane; but it may occur in the tympanum proper, retained by the insufficient opening of a small perforation, or in the aditus.

The *diagnosis* is made by a bent probe passed into the tympanum, displacing the masses and bringing them into view; or by the tympanic syringe.

The *treatment* consists in warm antiseptic syringing with carbolic acid (1 : 80) or corrosive sublimate (1 : 5000), by means of a tympanic syringe; and if this is not sufficient to clear out the cavity thoroughly, solid masses must be displaced and removed by a bent probe, blunt ring, curet, or Ludwig's incus-hook. Especially with cholesteatomatous masses, instrumental removal is necessary. Inflation by the Eustachian catheter will sometimes help removal, and often injections through the catheter will materially assist the cleansing process.

Granulations and **polypi** are inflammatory new growths from the superficial tissues of the tympanic mucous membrane, of the membrana tympani, or of the meatus. They are the most common foci of inflammation, and vary in firmness according to the amount of fibrous tissue they contain. They are in size from a pin's head to large polypi filling the entire meatus, and may grow from any portion of the tympanic mucous membrane, from the edges of the drum-membrane, from the ossicles, or from any portion of the meatus.

After cleansing and drying the meatus, they may be seen on inspection as red fleshy growths, if within the field of view, and may be suspected in parts beyond the field of view if bleeding follows the gentle use of a bent tube. Small papillary granulations over a circumscribed area are usually associated with carious bone.

The *treatment* may be by removal with forceps, the snare, or the curet when the area of their attachment is circumscribed and they are more or less pedunculated; by shrivelling with alcohol (95 per cent.) when they are extensive and soft in structure; or by destruction with argentic nitrate. Cocain hydrochlorate (10 per cent. solution) is of great value as a local anesthetic when it can be applied directly to the seat of operation. Direct removal is preferable; and the Blake-Wilde snare is in most cases the best instrument. For small pedunculated growths I prefer No. 36 copper wire; for larger and firmer growths No. 28. The snare may be used either as an evulsor, when the wire is drawn against a cross-bar at the orifice of the cannula, or as an écraseur, when the wire is drawn wholly into the cannula in the absence of a cross-bar. Evulsion is to be preferred if the attachment is to parts physiologically unimportant, such as the promontory or meatus; the écraseur action, if the attachment of the growth is to important parts, as the ossicles or drum-membrane. If the removal is very thorough the seat of the growth should afterward be painted

with a saturated solution of boric acid in alcohol (95 per cent.) till a new epidermis has formed over it.

Shrivelling by alcohol is a slower process, but is very effectual with soft growths; the alcohol coagulates the albumin on the surface, contracts the blood-vessels, and under its use, by either painting or by instillation, the granulations slowly shrivel and finally disappear.

Destruction by argentic nitrate fused on the end of a probe is adapted to any considerable remnants remaining after the use of the snare; if they are fibrous, the caustic should be bored into them with some force; if soft, destruction of the surface only is desirable.

Whichever method is adopted, the treatment should be continued till the growth has disappeared and its site become covered with epidermis.

Caries may occur in any part of the tympanum, and be of any extent, from a minute spot up to the entire petrous bone. It may be suspected beneath circumscribed groups of small granulations; it is often situated at the attachment of large granulations or polypi. Facial paralysis coming on during the course of a suppuration of the tympanum is in almost all cases due to caries of the tympanum, the inflammation extending into the Fallopian canal and causing pressure-paralysis from swelling of the perineurium.

The seats of predilection for caries are the floor of the tympanum, the inside of the lateral wall of the floor or the lower part of the labyrinthine wall, the lateral wall of the aditus, the wall of the promontory, and the lateral wall of the epitympanum. Caries of the aditus and epitympanum is especially common with cholesteatomatous collections. Exploration of the cavity with a bent probe will give the characteristic grating of carious bone.

Treatment.—A cure of caries only occurs by getting rid of the diseased bone, either by disintegration or by the formation and removal of a sequestrum. A natural disintegration is not only a slow but an uncertain process, for as one portion of bone is thrown off, infection and caries of neighboring portions follow. Therefore, if the caries is limited in extent and can be reached without injuring important parts, artificial disintegration by curetting is advisable. Tympanic sequestra are not uncommon; they are especially liable to form in the virulent suppurations accompanying scarlet fever and diphtheria in children. As soon as loosened they should be removed by forceps through the meatus if small, or by a mastoid or tympanomastoid operation if very large.

Carious ossicles, when extensively diseased, are practically sequestra, and require removal.

The most common seats of caries are the body and long process of the incus and the external and medial surfaces of the head of the malleus. The incus is the most frequently affected, the malleus next, the stapes very rarely.

Not only are carious ossicles foci of infection in themselves, but they, with their ligaments, muscles, and folds of mucous membrane, are most serious obstructions to drainage of the whole epitympanum, and consequently favor the development of caries of the walls of that cavity. Where caries of the epitympanum as well as of the ossicles exists, an *evisceration of the entire tympanum*, by removal of the whole

drum-membrane, the malleus, and the incus, is necessary to attain surgical cleanliness.

The steps of the operation are as follows : 1. Separation of the drum-membrane by incision around its periphery as near the tympanic ring as possible. 2. Tenotomy of the tensor tympani muscle by means of a Schwartze's tenotome. 3. Disarticulation of the incudostapedial

FIG. 425.—Instruments for intratympanic operations: A, adjustable handle; B, angled knives; C, Ludwig's incus-hooks; D, Schwartze's tenotomy- and synechia-knives; E, drum-membrane knives; F, Sexton's forceps.

joint by a small sharp-pointed knife set at nearly a right angle with its shaft. 4. Removal of the malleus by seizing it with strong forceps at or near the short process, carrying it slightly inward to disengage its neck from the incisura Rivini, and then removing it. 5. Removal of the incus by passing a Ludwig incus-hook upward into the epitympanum and then sweeping it backward, thus bringing the incus into the meatus,

and then withdrawing it with forceps.   Absolute immobility of the head is required, and general anesthesia is usually necessary.

The ossicles having been removed, the whole cavity should be freed from granulations, cholesteatomatous collections, and detritus by the flat incus-hook and by the tympanic syringe.   During the operation the relations of the facial nerve to the tympanum should be kept in mind, and care should be exercised not to injure the Fallopian canal, the bone of which is very thin along its horizontal tympanic portion.

Suppuration of the labyrinth, due to infection of that cavity from the tympanum, is in exceptional cases the focus which keeps up the chronic tympanic disease.   It is characterized usually by a dull, continuous pain in the depths of the ear and by a total loss of bone-conduction.   The risk of the suppuration extending from the labyrinth to the brain, along the meatus internus or aqueductus vestibuli, is very considerable, and every care should be used to prevent obstruction to the evacuation of the pus which may exist in the tympanum.   The labyrinthitis itself cannot be treated locally.   The inflammation usually runs its course in a few months, and, if caries does not result, heals with a permanent and total loss of hearing.

Mastoiditis is the last of the complications which may keep up a chronic tympanic suppuration: it is described later.

Having got rid of the infecting focus in any or several of the complications described above, it remains to cure the general tympanic mucous membrane, which is almost always infected secondarily. Often, as soon as the primary focus is removed, the tympanic membrane becomes dry and pale; if, however, this is not the case, it should be treated by syringing, by the application of a saturated solution of boric acid in absolute alcohol, or, if edematous, by insufflation of powdered boric acid in small quantities.   The Eustachian tube, if closed, should be rendered pervious by catheterization; and any condition of the nasopharynx which keeps up edema and congestion of the mucous membrane should receive appropriate treatment.

The closing of the perforation after cessation of the otorrhea is uncertain.   Even a loss of two-thirds of the drum-membrane may be replaced by cicatricial tissue which closes the tympanum externally; in other cases an opening not larger than a pin's head may remain through life.   The healing depends upon the regenerative power of the membrane.   In many cases, instead of throwing out plastic material which organizes into a cicatrix, nature covers the edges of the perforation with epithelium, and thus leaves a permanent fistula; and a patient with such a permanent perforation is continually exposed to the risk of fresh infection from the entrance of dust or fluids.

Sometimes there is an apparent cure of chronic suppuration, with entire disappearance of the discharge; but a focus of infection may remain in the epitympanum or in some encapsuled spot; and the microorganisms may become invasive, weeks or months afterward, from any cause which excites congestion of the mucous membrane.

Mastoiditis, an infective suppuration of the interior of the mastoid process, probably accompanies every acute suppuration of the tympanum; but as the inflammation of the tympanum subsides that of the mastoid usually disappears also.   Clinically, we speak of mastoiditis

only when that becomes the prominent feature in the case, either by continuing after the tympanic inflammation subsides, or from its intensity overshadowing the tympanic disease.

The anatomical peculiarities of the mastoid influence the disease so much that a brief consideration must be given to them. The mastoid is by no means always the hollow shell of bone filled with large pneumatic cells that is generally described. The investigation of Zuckerkandl on 250 mastoids showed that the interior was pneumatic in only 36.8 per cent.; was both pneumatic and diploëtic in 43.2 per cent.; was fatty, diploëtic, or sclerosed in 20 per cent.

There is no means of determining the character of the mastoid interior with certainty. A large, prominent mastoid is more likely to be pneumatic than a small, depressed, ill-developed one; the mastoid in a dolicocephalic skull is more likely to be well developed and pneumatic than in a brachycephalic skull. Sclerosis is undoubtedly a pathological condition, the result of organization of the cellular infiltration in the medullary spaces of the bone, and may occur in any and every part of the bone, converting it into an ivory-like mass; it may be suspected in any case of long-continued suppuration.

The cortex varies from $\frac{1}{24}$ to $\frac{1}{2}$ inch in thickness. When both pneumatic and diploëtic, the pneumatic cells may be only in the tip, and all the rest of the process diploëtic; or the whole external portion may be diploëtic, and the deeper portions pneumatic. Again, the extent to which the cancellated structure (pneumatic or diploëtic) extends varies very much: in exceptional cases, it runs far back, even an inch or more, into the occipital bone; in other cases, far inward; in still others, deeply inward and downward. The only constant cavity is the antrum. The form of the sigmoid groove for the lateral sinus influences the size of the mastoid: if it projects externally, it diminishes the width and lateral depth of the mastoid very much; if, on the contrary, it does not curve outward, there may be a space $\frac{3}{4}$ inch wide between the posterior edge of the osseous meatus and the sinus.

According to the structure of the interior of the mastoid, an infection of its mucous membrane may give rise to an empyema of the pneumatic spaces, an osteomyelitis in the diploëtic structure, or an ostitis in the cortical substance. Not infrequently all three pathological processes are found in the same mastoid.

The interior of the mastoid is liable, also, to the same forms of desquamative inflammation that occur in other parts of the ear, filling the pneumatic cavities with cholesteatomatous masses. This takes place only in the chronic varieties of the disease. The infection in mastoiditis is by the same organisms that infect the tympanum.

Symptoms.—Sensitiveness of the bone on deep pressure is the one important symptom, and is present in a very large proportion of the cases; but is occasionally wanting when the cortex is very thick, or when, as sometimes occurs in a chronic mastoiditis, the suppuration is confined to a small portion of the bone. Fever is the exception rather than the rule. It is most common in children, and, with adults, in the mastoiditis accompanying acute suppuration of the tympanum. Pain is often present, and is referred directly to the mastoid, especially in the more acute forms of the disease; but it is often wanting. Leukocytosis may or may not exist. With ostitis or osteomyelitis of some duration there are often marked objective symptoms, due to the infection having penetrated the bone and extended to neighboring parts. These extensions are:

a. Outward through the external cortex, with resulting edema and subperiosteal abscess on the outer surface of the bone.

b. Forward to the meatus, with edema and subperiosteal abscess in the meatus.

c. Upward through the roof of the mastoid, with extradural abscess and its results in the cerebrum.

d. Inward through the inner cortex of the mastoid, with phlebitis of the lateral sinus and extradural abscess and its results in the cerebellum.

e. Downward through the floor of the mastoid, with cellulitis beneath the deep cervical fascia of the neck.

One of the most common objective symptoms of suppuration of the antrum is an edematous swelling of the upper posterior wall of the meatus from the periphery of the drum-membrane outward. This is due to the anatomical relation of the antrum to this portion of the wall, only a thin layer of bone separating the antrum from the meatus. Mastoiditis, as has already been said, is often the important focus of inflammation which keeps up a suppuration of the tympanum, and should always be suspected, even if all other symptoms are wanting, when an acute tympanic suppuration, showing no other of the complications already mentioned, persists in spite of appropriate tympanic treatment.

Treatment.—The sensitiveness of the bone that is often present in the first three or four days of the acute tympanic suppuration does not necessarily require direct treatment; as has been said, it often rapidly diminishes as the tympanum is relieved. If, however, it continues or tends to increase after thorough evacuation and cleansing of the tympanum, ice should be applied continuously, either by means of a Leiter's ice-coil or by an ice-bag, day and night for three or four days, taking care that the bone is kept thoroughly chilled. Sprague's is the best form of ice-bag. If the pain is very severe, 3 or 4 leeches over the mastoid will sometimes give very much relief; but they tend to obscure edema and other symptoms of ostitis, and are not free from the danger of erysipelas. On these accounts they are rarely advisable. If the sensitiveness of the bone continues for seven or eight days, there is a true mastoiditis; but if no urgent symptoms show themselves, ice and the tympanic treatment may be continued, not infrequently producing a gradual subsidence of the sensitiveness of the bone. Should urgent symptoms appear, opening of the bone is necessary. In cases of mastoiditis accompanying acute tympanic suppuration, urgent symptoms are any appearances pointing to extension of the inflammation to neighboring parts, edema or swelling over the mastoid, great edema of the meatus, swelling below the tip of the mastoid, continuous headache or any disturbances of the sensorium pointing to either the cerebrum or cerebellum, chills or other pyemic or septicemic symptoms, and finally, continuous severe pain in the mastoid itself.

During chronic suppurations of the tympanum there may develop an acute mastoiditis, for the treatment of which the above rules apply; but with these chronic tympanic diseases there is often a slow chronic caries of the interior of the mastoid, for which the tympanic and ice treatment are useless. These may equally with the acute cases, develop any of the extensions and complications already spoken of, which would call for immediate opening of the bone. They often require opening of the bone also, in order to get at and remove the caries. Cholesteatomatous collections within the bone, the results of mastoiditis, also require opening of the bone.

Operations.—There are two distinct operations for opening the

bone: one, which may be called the *antrum-operation*, consists in exposing the antrum and mastoid only (the Schwartze operation); the other exposes the whole interior of the mastoid, tympanum, and meatus, and is a complete exenteration of all the middle-ear cavities (the Schwartze-Zaufal or Schwartze-Stacke operation). The first is indicated for empyema, ostitis, or osteomyelitis of the mastoid; the second for these pathological conditions of the mastoid when combined with ostitis of the aditus, epitympanum, tympanum, and meatus, or associated with cholesteatomatous collections.

In both operations certain variations in the anatomical relations should be kept in mind : 1. The floor of the middle fossa of the skull is formed by the roof of the antrum and tympanum, and may vary in its position by as much as 2 cm. ($\frac{3}{4}$ inch) up or down. Measurements, however, on many skulls show it is never 1 cm. (0.4 inch) below the linea temporalis. This linea is sometimes not easily found, and another rule for avoiding the middle fossa is to keep 3 mm. below a horizontal line drawn backward from the upper edge of the meatus. 2. The degree of outward curvature of the sigmoid groove, which contains the lateral sinus, varies very much. With extreme curvature, it may lie in direct contact with the external cortex of the mastoid or even within $\frac{1}{8}$ inch of the posterior wall of the meatus. Its position cannot be foretold, and wounding of the lateral sinus can be avoided only by careful work with the gouge and mallet and the omission of all boring instruments, like trephine or awl. 3. The perpendicular portion of the Fallopian canal which carries the facial nerve may lie $\frac{1}{8}$ inch inward when measured from the posterior periphery of the drum-membrane ; or it may lie almost directly opposite this periphery. 4. The external or horizontal semicircular canal lies on the medial side of the aditus, varies somewhat in an anteroposterior direction, and if it projects backward forms the anteromedial wall of the antrum. It lies above and is separated from the Fallopian canal by a thin lamella of bone, and both it and the facial nerve may easily be injured by too deep chiselling.

The Antrum-operation.—The antrum is the objective point of the operation. It lies, roughly stated, about 12 mm. ($\frac{1}{2}$ inch) very slightly inward, upward, and forward from a point on the external cortex 5 mm. ($\frac{3}{8}$ inch) behind the spina supra meatum ; but as the middle fossa of the skull often dips downward considerably between the petrous and squamous bones, the direction of the first part of the opening should be directly inward, and the upward direction taken only after penetrating from 5 to 8 mm. Roughly speaking, the floor of the antrum is about on a level with the superior wall of the meatus, and the cavity itself is 7 to 12 mm. ($\frac{1}{4}$ to $\frac{1}{2}$ inch) backward from the superior posterior edge of the tympanic ring.

The mastoid is exposed by an incision through the periosteum from 1 cm. above the superior edge of the meatus down to the tip, and from $\frac{1}{2}$ to 1 cm. posterior to the insertion of the auricle.

The skin and periosteum are pushed forward so as to expose the posterior superior edge of the meatus with its spina supra meatum ; and then backward to expose the whole mastoid. From this spina a horizontal line is drawn backward, and an opening is made with the upper edge 3 mm. ($\frac{1}{8}$ inch) below this line, and its anterior edge 5 mm. ($\frac{3}{16}$ inch) behind the meatus. The seat of election is marked in most bones by a flat, depressed surface (the fossa mastoidea). With a gouge and mallet the bone is removed in thin chips over a surface 7 to 10 mm. (0.3–0.4 inch) in diameter, always parallel with the meatus. The cortex varies in thickness from a thin shell to 1 cm. On penetrating it, large pneumatic cavities may be opened; and these should be explored with a probe upward to determine the roof of the mastoid; and inward and backward to define the posterior fossa of the skull.

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The partition-walls between the cells should then be broken down, and the whole interior cleansed out with a curet till the antrum is reached at a depth of not over $1\frac{1}{2}$ cm. ($\frac{9}{16}$ inch).

In other cases, on penetrating the cortex the interior is found to be partly or wholly diploëtic. Greater care is then necessary; the opening should be continued inward parallel with the meatus, by means of a curet or a hand-gouge, to a depth of 5 to 8 mm. ($\frac{1}{4}$ to $\frac{3}{8}$ inch); and then, if no pneumatic cavities are reached, the opening should be directed slightly forward, upward, and inward to reach the antrum, but never carried beyond $1\frac{1}{2}$ cm. ($\frac{9}{16}$ inch) from the external anterior edge of the cortical opening for fear of wounding the facial nerve or horizontal semicircular canal.

In still another class of cases, either those with long-continued suppuration or those in which the mastoid has been diseased at some previous time, the deeper in the opening is carried the denser the bone becomes (osteosclerosis). These are much the most difficult operations, for it is impossible to locate the internal landmarks with the probe. The bone should be removed in small chips straight inward parallel with the meatus for 5 to 8 mm. ($\frac{1}{4}$ to $\frac{3}{8}$ inch), and then the opening should be carried very slightly upward, forward, and inward, but, as above, not deeper than $1\frac{1}{2}$ cm. ($\frac{9}{16}$ inch) from the anterior edge of the external opening. Often, after going through sclerosed bone for 7 to 10 mm. (0.3–0.4), diploëtic bone is met. In very exceptional cases sclerosis may even obliterate the antrum, and $1\frac{1}{2}$ cm. ($\frac{9}{16}$ inch) is the extreme depth to which it is justifiable to penetrate.

In all varieties of mastoiditis carious bone may be found in any position, and should be thoroughly removed, even if it exposes the dura, as is very often the case. The cancellated structure is often carious, not infrequently the roof of the mastoid next the cerebrum, and often the inner wall next the lateral sinus and cerebellum. By pushing the dura away the affected bone can be removed with a curet.

The treatment of the interior of the bone after opening the antrum must vary according to the conditions found. In empyema the pus is evacuated, all granulations removed, partition-walls of the cells broken down and thoroughly cleansed. In inflamed diploë remove all of the cancellated structure so far as is possible; in ostitis remove all softened bone so far as it may be done without injuring the labyrinth and facial nerve. To succeed in fulfilling these indications, it is often necessary to enlarge the original opening in the cortex, or even to remove the entire external cortex of the mastoid down to the tip.

After thorough cleansing the interior of the bone should be packed with sterile or iodoform gauze, the edges of the deflected periosteum sutured together over any of the cortical substance which is exposed, but the opening into the bone left free, and an aseptic dressing applied. The subsequent treatment is according to the rules of general surgery.

The exceptions to the above general rules are those cases in which there is a carious fistula through the cortex. Such fistulæ are always to be suspected when the tissues are edematous or swollen. They are almost certain to exist wherever pus is found between the periosteum and bone. In these cases the fistula should be exposed and followed inward instead of opening through the healthy cortex. With an

external fistula (extension outward), deflection of the periosteum will expose it; an anterior fistula (extension forward) is exposed by continuing the primary deflection of the periosteum, as described, along the posterior wall of the meatus. With fistula through the base of the bone (extension downward), the periosteum should be deflected from the posterior aspect of the tip, and exploration made with a bent probe or director along the digastric groove; and the fistula having thus been found, it should be exposed by removing the external cortex of the tip, and the cellulitis of the neck treated on general surgical principles.

The Tympanomastoid Exenteration.—This operation, often spoken of as the Schwartze-Zaufal or Schwartze-Stacke operation, and more recently as the *radical operation*, is adapted to cases in which ostitis

FIG. 426.—Tympanomastoid exenteration (soft parts not shown). The wall of the sigmoid sulcus is seen in the back of the mastoid opening, and the ridge of bone protecting the facial is preserved between this and the meatus. If the mastoid is diseased, its whole external cortex should be removed to the very tip.

or cholesteatomatous collections involve more than the mastoid. It consists in transforming the mastoid, antrum, aditus, epitympanum, and meatus into one large continuous cavity, with perfectly smooth and healthy walls, and then having it heal, not by granulations filling the cavity, but by an epidermis lining the whole space.

This epidermis can grow only from epidermis, which must extend inward from the meatus or edges of the wound or be transplanted into the cavity. As there is necessarily a large surface of bone exposed by the operation, the more this can be covered at the time the quicker the healing; and the more epidermis there is placed in the cavity, the more rapid epidermization of the whole will take place. On these accounts the turning into the cavity of a flap of skin from the outside seems to me a great advantage: in practice, it has worked admirably, although it almost necessarily makes a permanent opening behind the auricle.

The following details of the operation as I have done it, while not strictly adhering to the methods, as published, of either Schwartze, Zaufal, or Stacke, borrows something from each of them.

The steps of the operation are: 1. Formation of two flaps, one of periosteum and one of skin, and exposure of the operative field; 2. Extirpation of the posterior and superior lining of the osseous meatus; 3. Opening of the antrum and removal of the posterior wall of the osseous meatus, with removal of the drum-membrane, malleus, and incus, if present; 4. Removal of the epitympanum; 5. Exenteration of the entire mastoid, antrum aditus, and epitympanum; 6. Splitting of the membranous meatus, stitching, and bandaging; 7. After-treatment.

1. An incision is made through the skin only, beginning at about $\frac{1}{8}$ inch above the anterior superior insertion of the auricle, and prolonged at the same distance from the auricle down to the very tip of the mastoid, thence backward about $\frac{1}{2}$ inch, thence up along the posterior part of the mastoid, slightly diverging from the anterior cut, to the extreme upper part of the mastoid. This skin is dissected from the underlying tissue and turned upward. The auricle is dissected off without the periosteum, as far as the superior and posterior edge of the meatus, and turned forward. Now a flap of periosteum is made by incising to the bone, along the linea temporalis, as far back as the periosteum is exposed by the preceding dissection, and by another perpendicular incision close to the meatus: this triangular flap of periosteum is separated and turned downward and the entire mastoid is exposed. Then all bleeding is checked.[1]

2. The cartilaginous meatus is separated from the osseous meatus in its superior and posterior portions, and held, together with the auricle, forward and downward with a long blunt hook or by a loop of gauze. The lining of the meatus is incised from the drum-membrane outward, along the anterior superior and inferior posterior walls; this rectangular piece of periosteum is raised and removed.

3. The antrum is opened as described above for the ordinary antrum-operation, and then with chisels and mallet the wedge of the bone between the mastoid opening and the meatus is removed, the lower cuts being carried externally nearly to the floor of the meatus, but as they get deeper being sloped upward. If there are remnants of the drum-membrane in position, it is sometimes well to remove them before chiselling away the final wedge which opens the aditus. This is done by dissecting off the fibrinous tympanic ring with a small knife and removing the drum-membrane, together with the malleus, if present. In a large proportion of the cases, however, in which this operation of exenteration is necessary, the drum-membrane has been already destroyed. A bent probe may now be inserted through the aditus into the antrum as a guide, or a flat guard used, and the final wedge of bone removed, making the opening from the aditus to the antrum as wide as possible without injuring the facial nerve.

4. The external wall of the epitympanum should now be removed with a chisel bent slightly backward, and the whole of this cavity exposed. The incus, if present, is then taken out with forceps after

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[1] Since this was written I have used a different method of obtaining the flaps, which seems to me an improvement in that it covers the facial ridge (where the greatest difficulty in obtaining epidermization is experienced) with skin immediately. By this method the skin-flap is turned down and the periosteum turned up, so that when inserted in the cavity the skin lies along the floor and facial ridge, and the periosteum along the roof.

disarticulating it from the stapes with the small knife already described under Carious Ossicles.

5. The greater part of the external cortex of the mastoid should now be removed with all of its cancellated structure. All prominences and ridges should be smoothed off with a curet or surgical engine (Fig. 427), beginning with the mastoid, then successively the antrum, epitympanum, roof of the tympanum, and its walls. Every portion of the remaining bone should now be examined with a probe for caries, especially the posterior wall of the antrum, and its lower inner corner

FIG. 427.—Portable engine adapted for the author in 1879 by Dr. William H. Rollins. It works admirably for light cutting, but it lacks the power for very heavy work.

next the lateral sinus and the roof of the antrum and tympanum; and if anything suspicious is found, it should be removed, even if it exposes the dura. Great care must be exercised against injuring the Fallopian canal and horizontal semicircular canal. The former is exposed to injury in its horizontal course through the tympanum, and in its perpendicular course downward from the aditus; the latter, at the inner wall of the aditus. The posterior wall of the meatus should be removed in such a way that a ridge of solid bone shall slope outward and downward from the floor of the aditus between the mastoid and meatus.

Within this ridge lies the Fallopian canal, and none of it should be cut away on the medial side of the tympanic ring. After the cavity has been fully prepared, it should be douched gently with corrosive sublimate (1 : 5000), to remove all débris.

6. The cartilaginous meatus should now be slit from near the concha throughout its entire length along its posterior wall, thus making two triangular flaps, the corners of which should be stitched by catgut sutures to the external tissues, so as to stretch them, one up and the other down. The auricle should then be sutured into position as far down as the linea temporalis, the whole opening cleansed as before and dried, and the skin and periosteal flaps turned into the cavity, where they should be tamponed with iodoform or sterile gauze, and every minute portion of the cavity should be likewise tamponed with gauze. The skin over the lower portion of the mastoid should be sutured and an aseptic dressing applied.

7. The after-treatment consists, in general, in keeping the cavity packed in every little crevice with gauze till it has become covered with fine granulations and till these are again covered with epidermis. Strict asepsis should be practised; and if the interior has been thoroughly cleansed at the operation, it can often be kept nearly or quite aseptic. The first two or three dressings need not be at intervals shorter than five days. After that time, as granulation-pus forms, they must be more and more frequent, and by the fourth week must usually be done daily. About the fourth to the sixth week the development of granulations is most active, and constant vigilance must be used to prevent their formation across any portions of the cavity, so interfering with its perfect unity. If exuberant, they must be removed with a snare. Only the most unremitting attention on the part of the surgeon himself in packing every minute crevice and in removing redundant granulations can give the best result. When granulations have formed over the exposed bone and have become fairly firm, skin-grafting will assist epidermization very much. After a few weeks of packing, usually from five to seven, when the granulations have become well organized and are shrivelling up, the omission of all packing and bandaging, with free exposure to the air, will assist the formation of epidermis. After the first two weeks succeeding the operation, the insufflation of small quantities of aristol or dermatol at each dressing is of value as an antiseptic, and later also as a protection to the young epidermis. The duration of the after-treatment varies from four to twelve months, and should cease only when the cavity is completely epidermitized and dry.

OTITIC DISEASES OF THE BRAIN.

The extensions of suppuration inward or upward from the ear produce the otitic diseases of the brain; and such extensions may take place from caries of the bone next the brain, or through any of the natural passages which lead from the ear to the inside of the cranium (commonly the labyrinth). The extension may also occur through some of the blood-vessels or connective-tissue fibrils which pass into and through the bone from both tympanum and dura. If the extension is through the roof of the temporal bone, the brain disease is in the cere-

brum; if through the inner wall or labyrinth, the brain disease is in the cerebellum. The brain is infected by the same microbes which infect the ear. The most common points of extension to the brain are

FIG. 428.—1, Foramen ovale; 2, caries into the vestibule; 3, caries into the external semi-circular canal; 4, caries of the Fallopian canal, with a wire where the nerve was exposed; 5, caries into the superior semicircular canal, with a bristle passing through it and out at the caries of the vestibule.

through the inner wall of the mastoid, and through the roof of either antrum or tympanum, by caries of the bone.

The relative frequency of otitic brain disease is well shown by the Prussian mortality statistics for 1885, viz.:[1]

			Deaths from Otitic Brain Disease.		
Age.	Total inhabitants.	All deaths.	Total.	In 10,000 living.	Percentage of all deaths.
0–10	7,110,695	371,323	811	1.14	0.22
10–20	5,726,644	26,130	1346	2.35	5.15
20–30	4,625,908	33,516	1291	2.79	3.85
30–40	3,596,465	38,269	553	1.53	1.44
Above 40	7,456,231	247,621	536	0.72	0.21
Unknown	2,527				
	28,518,470	716,859	4537		0.63

The infections of the brain may produce—

(1) Pachymeningitis externa purulenta; (2) leptomeningitis purulenta or arachnitis; (3) abscess of the brain; (4) phlebitis and thrombosis of the sinuses of the dura and of the jugular vein.

[1] Körner, *Die Otitischen Erkrankungen des Hirns, der Hirnhäute und der Blutleiter.*

1. **Pachymeningitis externa purulenta** is a suppurative inflammation of the external surface of the dura, and is by far the most common of the otitic intracranial complications. It may be circumscribed, with the dura adherent to the bone on its edges, giving an extradural abscess; or general over a large extent of dura. It is almost always due to caries of the bone. Jansen asserts it is twice as common with acute as with chronic disease of the tympanum. Its most common seat is about the lateral sinus (perisinous pachymeningitis); when in the middle fossa, it is called epitympanic pachymeningitis.

Jansen has found extradural abscess 4 times as common as sinus-thrombosis and 28 times as common as brain-abscess. With chronic aural suppurations it is twice as common in the posterior as in the middle fossa; in acute suppurations it is almost exclusively in the posterior fossa.

Symptoms.—In a very large proportion of cases the beginning and

FIG. 429.—Cholesteatoma of the petrous bone: 1, cavity of the growth; 2, carious opening into the jugular fossa; 3, meatus internus. Death from pyemia.

course of the disease are insidious and absolutely without symptoms, aside from those of the ear; and the diagnosis is first made at the time of operation on the bone, when, the mastoid or tympanum being opened, caries is found, and its removal reveals the pachymeningitis. In other cases, especially in children, the disease may begin with a chill and fever. Other symptoms, when present, are those of intracranial pressure—slow pulse, dizziness, nausea and vomiting, headache, either general or unilateral on the affected side, and somnolence. Localizing symptoms of any kind are very rare, for the pus is usually distributed in a thin layer. The treatment is surgical, and will be spoken of later.

2. **Leptomeningitis** is often combined with brain-abscess, sinus-phlebitis, or pachymeningitis; but more than half the cases are uncomplicated with these diseases, although almost always there is a certain amount of encephalitis.

There are two distinct varieties of the disease: the rapid, almost

apoplectiform variety, usually fatal in from a few hours to three days; and the insidious and protracted variety of two to three weeks' duration.

Symptoms.—Fever is almost always present: in the rapid variety it is almost always high (104° to 105° F.), with a very variable curve, and continuous; in the protracted form it is high, alternating with normal or subnormal. Headache referred to any part or to the whole head is the most prominent symptom, usually of great intensity, but often remittent; in exceptional cases it is only slight. Symptoms of irritation of the brain show themselves—restlessness, excitement, sensitiveness to noise or light, dizziness, nausea, delirium. From basilar
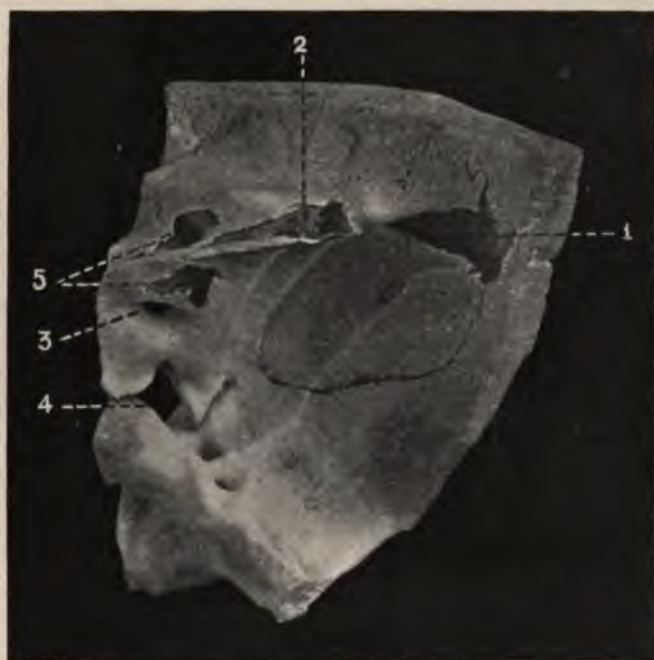
FIG. 430.—1. Caries of the sigmoid groove; 2, caries along groove of the superior petrosal sinus; 3, meatus internus; 4, foramen lacerum; 5, carious openings communicating beneath petrosal sinus. Death from pyemia.

meningitis, there may be symptoms of irritation and paralyses in the nerves of the brain, viz., paralysis of the ocular muscles, ptosis, narrowing or widening of the pupils without reaction to light, facial paralysis, disturbances of respiration. From irritation of the gray substance of the convexity, there may be convulsions of the extremities, monoplegic or hemiplegic paralyses; from exudation in the fossa Sylvii, occasionally motor aphasia. Constipation is almost always present.

Diagnosis in the rapid variety is easy: the high fever; excruciating headache; brain-irritation, with restlessness, photophobia, delirium, and unconsciousness; together with paralytic symptoms, sluggishness of the pupils, and strabismus, following rapidly one after another, leave no doubt when the disease of the ear and of the bone has been recog-

nized. With the protracted variety diagnosis is difficult, and often impossible until serious disturbances of the sensorium have set in.

The **prognosis** is highly unfavorable: coma occurs sometimes with convulsions, and death ensues. Ice to the head, leeches behind the ear and on the temporal region, with morphin subcutaneously, often give temporary relief. By exposure and incision of the brain-membrane in circumscribed leptomeningitis Macewen has in several cases effected a cure.

3. **Brain-abscess** is much more common from chronic than from acute tympanic suppuration.[1] One-third of all brain-abscesses are of otitic origin.[2] The bone disease almost always extends to the dura, and the abscess is usually in that portion of the brain contiguous to the bone disease: in 9.5 per cent. of the cases there are multiple abscesses connected by fistulæ. In the cerebrum the abscess is usually in the middle and posterior portion of the temporal lobe, near the petrous bone; occasionally it is in the frontal lobe, but very rarely in the occipital or parietal lobes. In the cerebellum it is usually in the outer and anterior portion of the lateral lobe, close to the petrous bone; but if the inflammation extends to the vestibule of the labyrinth, the suppuration may reach the brain along the internal meatus or aqueductus vestibuli, in which case the abscess is in the anterior portion of the cerebellum.[3] The abscess is generally connected directly with the suppurating ear; but in 6.6 per cent. of the cases[4] it is separated from the bone by normal brain-tissue, and the infection in these cases is assumed to be by phlebitis of the minute blood-vessels or by infection along the connective tissue which accompanies the blood- and lymph-vessels. The relative proportion of the cerebral to cerebellar abscesses is, before ten years of age, 18 per cent. cerebellar to 82 per cent. cerebral; after ten years of age, 63 per cent. cerebellar to 37 per cent. cerebral.[5]

Symptoms.—Four stages of the abscess can be distinguished:

1. The initial, from a few days to two weeks' duration, usually accompanied by inflammatory fever and symptoms of an acute encephalitis; often, however, so slightly pronounced as to be referred to the tympanic suppuration. 2. The latent, from a few weeks to several years' duration, with only occasional brain-symptoms, slight headache, depression, discomfort, and perhaps slight evening temperature. 3. The manifest, from a few days to even several months' duration, when the whole train of symptoms of abscess show themselves. 4. The terminal, usually rapidly fatal, due to increasing brain-pressure and brain-edema or to a rupture into one of the ventricles.

The manifest symptoms are divided by von Bergmann into (1) general, (2) brain- and brain-pressure, (3) local brain-symptoms.

The *general symptoms* depend upon the suppuration alone, evening temperature (generally low), anorexia, rarely chills. A steadily increasing temperature renders an abscess improbable; but slight, intermittent rises are common with abscess.[6]

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[1] Ninety-one per cent. from chronic, 9 per cent. from acute, Grunert; 83 per cent. from chronic, 17 per cent. from acute, Jansen.
[2] Pitt.   [3] Green, *Am. Jour. of Med. Sci.*, April, 1899, 4 cases.
[4] Körner, *op. cit.*   [5] Körner, *op. cit.*   [6] Oppenheim.

Brain- and brain-pressure symptoms are due to diminished space within the skull. There is headache, usually persistent; not severe, but varying in intensity, though its seat is no indication of the situation of the abscess. Slowing of the pulse is a valuable but inconstant symptom. There is often dizziness, sometimes nausea and vomiting. Constipation, disturbances of sensorium, slow cerebration, and drowsiness are also present. Convulsions, if from the temporal lobe, may be confined to the extremities and the facial of the opposite side; if from the cerebellum, they are more commonly general. Optic neuritis of slight degree is often seen. All these symptoms may disappear and then reappear. They are most pronounced during the evening fever; and if at this time the pulse becomes slower and the patient somnolent, the suspicion of abscess is increased.[1]

Local brain-symptoms are due either to direct injury of parts of the brain-substance or to action of the abscess on distant parts, or to injury of the cerebral nerves.

As the abscess is usually in the white substance, the injury does not express itself in any localizing symptoms; only when some center in the gray matter of the surface is involved are such symptoms to be expected. Abscesses are almost always in the temporal lobe of the cerebrum or in the cerebellum. From the gray matter of the temporal lobe we may have various forms of aphasia, viz., *paraphasia*, the use of a false word or name for objects; *amnesic aphasia*, the recognition of the use of an object, but inability to name it, although the name can be repeated, and when used by another is recognized; and *word-deafness*, in which speech is heard but not understood, seen with abscess of the gray matter of the first temporal convolution. All these may occur only when the abscess is in the left temporal lobe in right-handed persons, or in the right temporal lobe with left-handed persons. The only other center in the gray matter of the temporal lobe is the center for hearing, on the opposite side. In the cerebellum are no determined centers except that for optic aphasia[2] (inability to find the name for objects seen), due to interruption of the connection between the speech- and vision-centers.

Action of the abscess on distant parts is by pressure exerted through the intervening tissue; and any such action is limited in the cerebrum by the tentorium, and cannot, therefore, extend from the cerebrum to the cerebellum. It is also limited by the pia, and cannot extend from the temporal to the frontal lobe or island of Reil. It is not, however, limited toward the internal capsule; and from pressure here we may get crossed pareses of the extremities, crossed convulsions and tonic spasms, crossed pareses of the facial, and occasionally crossed hemianesthesia and hemiopia. In the cerebellum the extent of pressure is unlimited, and it may extend even to the medulla oblongata, causing death from paralysis of respiration; cerebellar ataxia and cerebellar vertigo are occasionally seen.

Of injuries of cerebral nerves, that of the third (oculomotorius), giving paralysis of the upper lid and pupil, is the most common; injury of the sixth (abducens) is rare. Injury of either of these may be from abscess in the temporal lobe pressing on the nerves. Paralysis of the

[1] Bergmann.   [2] Oppenheim.

seventh (facial) may occur from pressure of a cerebellar abscess on the meatus internus or from pressure on the pons, giving either a central paralysis on the same side, a crossed paralysis, or a paralysis of both sides. Injury of the fifth (trigeminus), giving neuralgia from direct pressure on the nerve in its course or on the Gasserian ganglion, may be due to abscess in the temporal lobe at the apex of the petrous bone.

Diagnosis of otitic brain-abscess in the initial and latent stages is often impossible; in the manifest stage it is uncertain, unless we are able to build up a complete and connected series of symptoms; it is especially difficult in children, in whom the nicer distinction of symptoms cannot be made out. It is easy when a fistula through the bone leads directly to the abscess; and of this character are the abscesses which are diagnosed by exposing the interior of the ear-cavities and finding the fistula there.

Of 40 brain-abscesses, the bone was diseased directly to the dura in 37 (92 per cent.); the bone diseased, but not to the dura, in 1 (2.5 per cent.); the bone healthy in 2 (5 per cent.).[1]

As a first help in diagnosis, we have the suppuration of the ear as an exciting cause; next, we look for general brain- and brain-pressure symptoms. The general brain-symptoms are in themselves not of diagnostic value, but are rather confirmatory in connection with other symptoms. Brain-pressure symptoms point merely to some process within the skull which is diminishing its capacity: this may be extra-dural abscess, brain-abscess, or tumor. To differentiate from extra-dural abscess by symptoms alone is often impossible: it can generally be done, however, by opening and exploring the ear-cavities. Symptoms of pressure on the internal capsule, with its crossed pareses of the extremities, crossed convulsions, and crossed hemianesthesia and hemiopia, if present, point to abscess, as do also disturbances of speech and interference with the cerebral nerves. To differentiate from tumor, we have in abscesses a distinct etiological cause (aural suppuration, trauma, putrid lung disease or empyema, fever, remission of head-symptoms); in tumor, absence of cause, rarely fever, and a steady increase in the head-symptoms without remissions. In children, how-ever, the coincidence of brain-tubercle and disease of the petrous bone is common, and in them, with symptoms of brain-pressure associated with disease of the bone, the diagnosis of brain-abscess must be made carefully. Brain-tubercles are usually multiple, and the existence of brain-symptoms, which can only be referred to several different situations, points to tubercles; while symptoms which refer the disease solely to those parts of the brain in which otitic abscess occurs point to abscess.

Treatment.—Operative evacuation of the abscess is the only treatment to be considered. Without this the disease is fatal. That the operation is often successful is shown by the statistics of Körner.[2] Of 76 cases in the cerebrum, 42 were cured, 34 died; of 16 cases in the cerebellum, 9 were cured, 7 died—*i. e.*, 56 per cent. of each were cured. To wait till a complete diagnosis of the presence and situation of an abscess is made is in the vast majority of cases to lose the only oppor-

[1] Körner, *op. cit.*　　　　　　　　　　　　　　　　[2] *Op. cit.*

tunity of saving life, for the full development of symptoms necessary for such a diagnosis in most cases show themselves only in the latest stages, just before death, when the vital forces are so reduced that operative procedure is not justifiable. For a fair chance of success the operation must be done early; and the fact already stated, that in 92 per cent. of otitic abscesses of the brain the bone is diseased directly to the dura, justifies and demands an exploration of the bone, even on slight suspicion of brain disease. If this is done by exposing the ear-cavities by the so-called radical operation, the disease can be followed inward from its source to the brain. The operations on the brain are spoken of later.

4. **Phlebitis of the sinuses of the dura and of the jugular vein** is more common than arachnitis and brain-abscess, but less common than pachymeningitis. It occurs usually in the lateral sinus, but occasionally in the superior or inferior petrosal or in the cavernous sinus, and occasionally in the jugular vein. In the lateral sinus, it is usually due to extension of inflammation from an extradural (perisinous) abscess or from ostitis of the sigmoid groove: in this situation, it is more common from chronic than from acute tympanic suppurations.[1] In the superior petrosal, it is due to pus-collection upon either the posterior or the upper surface of the petrous bone. In the inferior petrosal, it is due to suppuration of the labyrinth or caries at the apex of the pyramid. In the cavernous, it is usually due to extension of the thrombus from the lateral sinus. In the bulb of the jugular, it is more common from acute than from chronic tympanic suppuration, and is due either to extension through the floor of the tympanum or to the entrance of micro-organisms into the lateral sinus, which pass thence to the bulb, and there settle on account of the enlargement of the vein at this point.[2]

Sinus-phlebitis is very often complicated with pachymeningitis, arachnitis, or brain-abscess. In 82 per cent. of the cases the bone is diseased directly to the dura. Of 39 cases, the bone was diseased to the dura in 82 per cent.; bone diseased, but not to the dura, 7.7 per cent.; the bone healthy, in 10.3 per cent.[3] This explains the frequency of pachymeningitis (14 out of 20 cases)[4] as a complication.

Symptoms.—These may be divided, according to the pathological process, into those of phlebitis, thrombosis, suppuration of the thrombus, cerebral symptoms from stasis of blood.

The *phlebitis*, in itself, gives no recognizable symptoms. As the *thrombus* forms, it may obstruct the circulation in the veins which drain into the sinus, and we may have from interference with the cavernous sinus congestion of the ophthalmic veins, choked disk, edema of the eyelids and conjunctiva, protrusion of the eyeball, and congestion of the vena frontalis, and from the periphlebitic swelling occasionally paralysis of the oculomotorius (third), abducens (sixth), or neuralgic pains in the trifacial (fifth). From interference with the mastoid, emissary swelling and edema just behind and below the mastoid process. From thrombosis of the jugular, there may be cording of the vein, swelling of the tissues and glands, cellulitis of the neck, and possibly, but very rarely, from periphlebitis at the jugular foramen paralysis of the glossopharyngeus (ninth), or pneumogastric (tenth). All of these symptoms of

[1] Jansen.   [2] Leutert.   [3] Körner.   [4] Jansen, *op. cit.*

obstruction of the circulation are, however, generally wanting, for the
thrombus forms slowly in most cases, and a collateral circulation is very
soon established.

Suppuration of the thrombus gives usually the most pronounced
symptoms—pyemic and septicemic—beginning with a rigor, which in
most cases recurs, and high fever (104° to 106° F.), remitting or inter-
mitting several times a day, even down to the normal. Between the
chills the patients often say they feel well.

Metastatic infarcts from emboli may take place in various organs—
lungs, spleen, and joints—but most commonly in the lungs, for the
emboli are rarely small enough to pass these organs. They are most
common when the jugular is affected. Not all emboli are necessarily
infected, however, and there may be non-infected infarcts without
abscesses. Metastatic abscesses in the lungs are usually multiple and
situated in the periphery of these organs, occasionally breaking into the
pleura ; and their symptoms are those of a diffuse bronchial catarrh.
Non-infected infarcts may produce bloody sputa.

Of *cerebral symptoms* due to stasis of blood within the cranium, there
may be headache, diffuse or unilateral, on the affected side; vomiting,
chiefly in the beginning of the disease; congested papillæ and optic
neuritis. Optic neuritis is not as common, however, as was formerly
thought (of 27 cases, only 10 showed this symptom).[1] There may be
nystagmus (8 in 24 cases); psychic depression is common ; delirium is
occasionally seen, but serious disturbances of consciousness are, on the
whole, rare.

The chief aids in **diagnosis** are the existence of aural suppuration,
especially of the mastoid, and the pyemic symptoms—chills, sharp
variations in temperature, and the metastases. Inflammatory symptoms
in the bone in the neighborhood of the lateral sinus with the pyemic
symptoms are confirmatory. Cording of the jugular is a sure indica-
tion of the disease, occurring, according to Jansen, in one-third of the
cases (11 of 34).

The disease is most frequently confounded with typhoid, especially when the pyemic
symptoms are but slightly pronounced and when the sensorium is affected. There is the
same enlargement of the spleen, and occasionally a roseola-like exanthema ; but sinus-phleb-
itis generally begins rapidly, not gradually. Examination of the blood, if it gives a posi-
tive typhoid-reaction, proves the existence of typhoid; but absence of this reaction proves
nothing. Marked chills may cause confusion with malaria, but the uselessness of quinin
and the further course of the disease, with varying pyemic temperature, would exclude it ;
the presence of the plasmodium in the blood would prove the malaria.

Leukocytosis I cannot regard as confirmatory of phlebitis. In 124 blood-counts on 44
different patients with all varieties of tympanic suppuration, acute and chronic, it was pres-
ent in 79.5 per cent., and absent in 20.5 per cent. ; and the only conclusion I could draw
from a study of the series was that leukocytosis was of no diagnostic value in otitic phlebitis.[2]

It must always be borne in mind that sinus-phlebitis is often com-
bined with other otitic brain diseases ; less than half of the cases are
uncomplicated, and consequently the clinical picture is often confused
and bewildering, till opening of the bone reveals the path of disease
from the ear to the sinus. A natural cure of an uncomplicated case by
a connective-tissue obliteration of the sinus sometimes takes place, and
this is more likely to occur if continual reinfection is prevented by thor-
ough opening and cleansing of the suppuration in the bone. Many

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[1] Jansen.   [2] Green, *Jour. of Boston Soc. of Med. Sci.*, Nov., 1898.

cases, both complicated and uncomplicated, are cured by evacuation and cleansing of the sinus, which is described later.

Treatment of the Otitic Brain Disease.—From what has been said, it is evident that in all of the otitic brain diseases there may be a great variety of symptoms, many of them common to two or more of the pathological processes, and consequently not distinctive. It is also evident that several of the diseases may be present at once ; for instance, extradural abscess and sinus-phlebitis, pachymeningitis and brain-abscess, brain-abscess and arachnitis ; and that, therefore, although the knowledge and study of the symptoms are of value in showing an active brain disease, they often leave the surgeon uncertain as to its exact character or situation. The case is one of extension from an infected focus in the ear-cavities to other infected foci within the cranium ; and statistics show that, taken collectively, in 79 per cent. of the cases the path of extension can be followed—*i. e.*, the bone is diseased directly to the dura. By opening the bone, then, the disease can be traced inward, and, moreover, the ear is the original focus, still active and reinfecting continually, and the diseased bone requires to be removed in any case. The recognition of this principle of following the disease inward and removing all diseased bone justifies an early operation, without waiting for an exact diagnosis, in any case showing brain-symptoms. It also points out the course for the surgeon to pursue in the very considerable proportion of cases which he sees for the first time when the brain disease is so active that time is of greater importance than an accurate diagnosis. Clinical experience has proved that it is successful.

The *parts to be explored* for finding the path of extension are the roof of the antrum and tympanum, the inner wall of the mastoid, and the labyrinth. The only operation which will expose all of these parts at once is a tympanomastoid exenteration. This has already been described in speaking of mastoiditis. Having by this operation exposed the whole interior of the bone, the inner and upper walls should be carefully examined for ostitis and caries by a probe and by illumination with an electric light. If these conditions are found, all of the diseased bone should be removed to the dura. In the case of a carious fistula the bone is softened, and can be removed with a curet. If inflamed merely, but not softened, I prefer, when working over the lateral sinus, to thin the cortex gradually by a curet, hand-gouge, or surgical engine till it is perforated, and then continue the removal with a small rongeur rather than a chisel or gouge; for it has twice occurred to me that in raising the first chip of bone I have torn open the sinus, which was adherent to it by inflammation. In parts other than over the sinus, the bone can be chipped away with a chisel. The labyrinth should be examined in the same way for carious openings into it, both from the tympanum and from the aditus, where the external semicircular canal lies. If carious fistulæ are found, all the diseased bone should be removed with a small curet.

If **pachymeningitis** exists in the posterior fossa, on opening the inner wall of the mastoid the dura is seen to be dull instead of shining, of a dirty-gray or greenish color, covered with granulations, and with more or less pus on its surface. The pus may be in such quantity that it has pushed the dura away from the bone and formed an extradural

abscess. Having thus found the existence of pachymeningitis, the entire inner wall of the mastoid should be removed, or so much of it as is necessary to expose the limits of the meningitis. The pus should be wiped away and the granulations removed with a rather blunt curet down to the fibrous dura. The lateral sinus is exposed, and it should be remembered that sinus-phlebitis is a very common complication. The walls of the sinus in such cases are often necrotic, and over the sinus the curet must be used with delicacy. Having cleaned off the dura, it should be examined carefully for sinus-phlebitis and thrombosis, and for fistulæ through it.

The treatment of the sinus disease is considered later. A fistula through the dura means infection either of the arachnoid and pia or of the brain, which is considered later.

If the roof of the petrous bone is diseased, this should be removed and the dura exposed. Provided the mastoid is large and deep, and the tympanomastoid exenteration has been done as extensively as possible, there is often room enough to allow of the removal of either the antrum or tympanum roof, or both, through the primary opening of the bone. The dura can then be examined, and if diseased should be exposed thoroughly by chiselling away the bone through the linea temporalis from about 2 cm. (0.8 inch) above the meatus forward to the anterior edge of the meatus, and backward about $2\frac{1}{2}$ cm. (1 inch). In the case of an extradural abscess in this situation, such an opening is sufficient for thorough evacuation and cleansing: if, however, the dura is inflamed beyond the portions thus exposed, the opening in the bone should be enlarged with a rongeur to at least twice the above size. If the removal of the roof of the antrum and tympanum is impossible through the original tympanomastoid opening from lack of space, as may be the case when the roof lies very low and the mastoid is very shallow from outward projection of the sigmoid groove, the bone should be opened directly from the outside. The squamous bone should be penetrated about 2 cm. (0.8 inch) above the upper edge of the meatus, and then with chisels and rongeurs the opening should be enlarged downward, forward, and backward, exposing the dura over a space 2 cm. (0.8 inch) in height and $2\frac{1}{2}$ cm. (1 inch) in width, just where it bends from its perpendicular to its horizontal position. By pushing the dura back with a flat spatula, the roof of the petrous bone can now be removed just as far as it is diseased, either by a small rongeur or by curved chisels and gouges.

Having removed all granulations from the dura and cleansed it by gentle syringing with sterile salt solution, the auricle should be replaced by sutures in its upper and anterior portions, drainage provided for in the posterior part of the osseous wound by sterile gauze, and the tympanomastoid opening packed with gauze. The dura should be dressed often enough to keep it clean, and the healing takes place by granulation, organization and epidermization like the rest of the bony cavity, as described under Tympanomastoid Exenteration.

Leptomeningitis of otitic origin has until recently been considered as necessarily fatal, and its certain diagnosis was regarded as a contraindication for any operation. In its very beginning, however, when circumscribed, Macewen has in several cases effected a cure by exposure

and incision of the arachnoid and pia. It is only rarely that the diagnosis can be made early enough to find the disease in this circumscribed form.

With **abscess** in the third temporosphenoidal convolution, the most common seat of otitic cerebral abscess, after the tympanomastoid exenteration, the dura is exposed, as already described, above the upper edge of the meatus by an opening at least 2 cm. (0.8 inch) in height and $2\frac{1}{2}$ cm. (1 inch) in width through the linea temporalis, and certainly large enough to allow examination of the dura over the roof of both antrum and tympanum. As has been said, the abscess is usually in direct connection with the diseased bone by a fistulous tract; and the dura, after being exposed, should be searched for a fistula, especially in the vicinity of the diseased bone. If such a fistula is found, it points to the seat of the abscess, which may be just on the surface of the brain or from 1 to 2 cm. (0.4 to 0.8 inch) inward. The dura should then be cleansed antiseptically and opened by an incision 1 cm. (0.4 inch) long, in such a position that free evacuation and drainage will be possible, preferably just at the curve of the perpendicular and horizontal positions; and exploration should be made for the abscess with a director or trocar in the direction indicated by the fistula. If the abscess is found, the dura should then be opened freely by a crucial incision of at least 2 cm. (0.8 inch) in each direction, a narrow-bladed forceps passed into the abscess, through the opening made with the director, and then opened and withdrawn. The pus is often so thick and contains so much necrotic tissue that it does not evacuate readily, and the cavity should be washed out by douching under very slight pressure, a gauze drain should be inserted and kept in till all secretion ceases, and then be withdrawn gradually. It may easily happen that the fistula through the dura escapes detection, although diseased bone at the roof and other symptoms point to abscess in the third (lower) convolution. In such a case exploration should be made as just described, but may require to be made in several directions before the abscess is found.[1] As a rule, however, the abscess is within 2 cm. (0.8 inch) of the diseased bone. The depth to which these explorations may be carried without injuring specially important portions of the brain is of moment. These parts are the anterior, inferior, and posterior horns of the lateral ventricle, the lenticular nucleus, and the internal capsule. According to the measurements of Hansberg, at the level of 1 to 2 cm. (0.4 to 0.8 inch) above the meatus a puncture of $2\frac{1}{2}$ to 3 cm. (1 to 1.2 inches) directly inward may wound the inferior horn, and in the lower temporal convolution exploration directly inward should not be carried beyond $2\frac{1}{2}$ cm. (1 inch); but at an angle of 45 degrees with this perpendicular line, it may be carried 4 cm. ($1\frac{5}{8}$ inches).[2]

According to Körner, in only 6 out of 90 brain-abscesses was the abscess not connected with the diseased bone. These *exceptional*

[1] I would emphasize the importance of the exploring instrument being of good size, at least $\frac{1}{8}$ inch in diameter; for it has happened to me (*Amer. Jour. of the Med. Sci.*, April, 1899) to pass a full-sized director completely through a cerebellar abscess, as the autopsy showed, without obtaining a trace of pus.

[2] An average adult skull measures, according to Hansberg, $13\frac{1}{2}$ cm. (5.3 inches) across the temporal bones; and he found that the smaller the skull the nearer the inferior horn lies to the surface.

abscesses are situated in the cerebrum, either in the first (upper) temporal convolution or in the frontal or occipital lobes. To reach the upper convolution, the skull should be opened 2 cm. (0.8 inch) back from a point 3 to 3.5 cm. (1.2 to 1.4 inches) above the upper edge of the meatus; and at this level the ventricle lies from 4 to 5 cm. (1.6 to 2 inches)[1] directly inward, so that here exploration may be carried nearly 4 cm. (1.6 inches) perpendicularly inward, and to a greater distance at an angle of 45 degrees. To get at frontal or occipital abscesses, the skull must be opened over their situation, as determined by previous localizing symptoms.

With **abscess of the cerebellum,** after exposure of the inner wall of the mastoid, that structure is removed throughout its whole extent, thus fully exposing the lateral sinus and a portion of the dura in front of and behind the sinus. A fistula through the dura is next sought to point out the situation of the abscess which, with disease of the inner wall of the mastoid, is usually posterior to the sinus and in direct connection with the diseased bone; with labyrinthine inflammation it is anterior to the sinus and in connection with either the meatus internus or aqueductus vestibuli. If such a fistula is found behind the sinus, the opening in the bone should be enlarged backward till it is at least $1\frac{1}{2}$ cm. (0.6 inch) in diameter, the dura cleansed antiseptically, then opened by a short, straight incision, and exploration made as described for cerebral abscess. If the abscess is reached the dura should be split crucially, and the abscess evacuated and drained. The object of the short, straight incision for exploration is, in case no abscess exists, to allow the dura to be stitched, and so prevent prolapse of the brain. In case no fistula points to the situation of the abscess, exploration must be made. If the abscess has been produced by disease of the mastoid, it will be best reached by the opening behind the sinus, just described. If, however, the abscess is due to extension through the labyrinth from the tympanum, the infection reaching the brain through the aqueductus vestibuli or internal meatus, it usually lies in the anterior part of the cerebellum, 3 to 4.5 cm. (1.2 to 1.8 inches) from the opening behind the sinus, and will be more directly reached by removing the posterior wall of the petrous bone in front of the sinus and exploring from this point. In this position there is a space of about 1 cm. (0.4 inch) between the sinus and the inferior semicircular canal; and even if the latter is removed, good rather than harm will result, for the inflammation will have already destroyed the functions of the labyrinth, and the opening of the canal will allow cleansing of the labyrinthine cavity. If an abscess is opened from this point in front of the sinus a firm drainage-tube is necessary to prevent compression between the edges of the bone and a prolapse of the brain.

In the *after-treatment of all brain-abscesses* a careful watch should be kept for an increase in temperature, pulse, or brain-symptoms, which require cleansing of the abscess-cavity. Pressure from the tampon or drainage-tube may produce brain-symptoms; and as the cavity often closes quite rapidly, these should be correspondingly shortened.

Sinus-phlebitis and Thrombosis.—Caries or simple ostitis of the inner mastoid wall would lead to the removal of the diseased bone and

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[1] Hansberg, *Archives of Otology.*

consequent exposure of the sinus. A certain amount of discoloration of the external coats of the sinus usually accompanies pachymeningitis in the posterior fossa; but this does not necessarily mean thrombosis. On the other hand, the sinus may be closed by a solid thrombus, and yet appear perfectly healthy in its outer coats. Respiratory pulsations in the sinus are of no diagnostic value; they are rarely present in a healthy sinus. If a solid thrombus exists, it can be felt as a cord within the vessel; but there may be a small infected thrombus on the walls of the vein, not large enough to obstruct it or to give a cording of the vessel. Or, again, a solid, obstructing sinus may have broken down and be no longer felt as a cord. A perforated or collapsed sinus means phlebitis and thrombosis. In order thoroughly to examine the sinus, it should be exposed by removal of the bone for $1\frac{1}{2}$ to 3 cm. (0.6 to 1.2 inches). In case of doubt as to its condition, it should be explored with a small aspirator, thoroughly sterilized, when purulent serum will be found if it is infected at the point of aspiration, nothing at all if there is a solid thrombus, and healthy blood if it is unaffected. If diseased, the sinus should be laid open by an incision along its course, evacuated and cleansed, and the thrombus should be removed with a rather blunt curet as far as it is broken down. But if, as is often the case, the sinus is closed at its lower portion, near the bulb of the jugular, by a firm, solid thrombus, this should not be disturbed, for it is a protection against septicemia and emboli, and the opening and cleansing of the vessel just above it will in many cases prevent its breaking down. The same rule holds in regard to the upper portion of the sinus, where a firm, solid thrombus, if present, should be left untouched. The first part of the thrombus to break down septically is usually the part opposite the diseased bone, and this is the portion to be incised. Hemorrhage, if it occurs, can be readily controlled by a tampon of iodoform or sterile gauze. In exceptional cases abscess of the temporal lobe of the cerebrum is complicated with thrombosis of the lateral sinus, the clinical symptoms leading the surgeon to expose the temporal lobe first. In such cases, after evacuation of the abscess, the upper knee of the sinus can be exposed from the middle fossa by removing the bone backward from the original opening above the meatus to the angle of the parietomastoid suture, where the knee lies, and from here exposing the sinus in its descending portion by removing the bone. In this way both the middle and the posterior fossæ can be examined.

Zaufal, of Prague, first proposed in 1880 this opening and cleansing of an infected sinus, together with a simultaneous ligation of the internal jugular to prevent infection of the general system. The first operation without, however, ligating the jugular, which was closed by a firm thrombus, was in 1884, and was unsuccessful. In 1886 Schede had a successful case without ligating the jugular. In 1889 the first successful operation on the sinus, with ligation of the jugular, was reported by Lane,[1] followed by Ballance, in 1890, with 2 successful cases. Since then numerous recoveries after operation, both with and without ligation of the jugular, have been reported. The following table is from Körner:

[1] *Brit. Med. Jour.*, May 4, 1889.

Operations on the Lateral Sinus.

	Total.	Cured.		Died.	
With ligation of jugular . . .	41	26	63.4 per cent.	15	36.6 per cent.
Without ligation of jugular . . .	38	16	42 per cent.	22	58 per cent.
	79	42	53.1 per cent.	37	46.9 per cent.

The question of tying the jugular seems to me still an open one; the cases reported are too few for accurate conclusions to be drawn from them. In favor of ligation we have the fact that the jugular is the main channel by which infection enters the general system, and the statistics, so far as they go; against it are the dangers of a prolonged operation, the possible involvement of other sinuses, superior petrosal or cavernous, in which case ligation of the jugular would not prevent general infection; also the fact that the sinus is often closed by a solid, uninfected thrombus. Finally, in many cases there is such an infiltration of the tissues of the neck, either from periphlebitis or from extension of inflammation through the base of the mastoid—a gravitation-abscess, in fact—as to offer great and often unsurmountable technical difficulties in the operation itself.

CHAPTER XXIX.

SURGERY OF THE SKIN.

Dermatitis is an inflammation of the skin characterized by the occurrence of heat, redness, and infiltration, which may terminate by resolution or persist in a modified form by the destruction of the tissues through vesication, suppuration, ulceration, and gangrene. Dermatological distinctions between erythema, eczema, and dermatitis as independent conditions with specific anatomical lesions are of no practical importance.

The most common types of dermatitis are Dermatitis *traumatica*, D. *venenata*, D. *medicamentosa*, D. *calorica*, and D. *congelationis*.

Dermatitis traumatica, the inflammation of the skin produced by mechanical injury, is discussed in other sections of this work.

Dermatitis venenata is produced by chemicals, caustic, or toxic irritants which act upon the skin from without; and is thus distinguished from dermatitis medicamentosa, which is produced exclusively by the ingestion or action of medicaments or toxins from within. Common surgical examples of dermatitis venenata are the erythematous and eczematous eruptions which follow the contact of the skin with acrid, septic, pathological discharges. The constant dribbling of ammoniacal urine gives rise to balanitis and eczema of the scrotum. The balanitis of diabetes and of acute gonorrhea are also illustrative of this condition. Another group results from the repeated or the excessive use of strong germicidal agents, which act on the skin of the patient as well as upon that of the operator; in both cases individual susceptibility is frequently responsible for these manifestations. The frequency with which this form of dermatitis has made its appearance on the hands of operators has won for it the distinction of " surgeons' eczema." The culpable agents are usually the strong alkaline soaps and other soaps that contain an excess of active germicides; also strong solutions of carbolic acid, bichlorid, potassium permanganate, oxalic acid, chlorid of lime, and sodium carbonate (Stimson-Weir method), oil of turpentine, etc. Added to this, and perhaps worse than all, are the harsh frictions with the coarse brush. In addition to the agents previously referred to, mention should be made of iodoform, which, more than any other drug, is capable of producing in predisposed subjects the most formidable types of dermatitis.

Rhus-dermatitis.—Another familiar form of dermatitis is the eruption produced by the poison-ivy (Rhus venenata) and poison-oak (Rhus toxicodendron). In rhus-poisoning the symptoms come on within a few hours or days after exposure, with a sensation of heat and itching experienced in the parts exposed to the poison. Following the redness there is great tumefaction, with much vesication and the exudation

of a clear, serous fluid, which drips from the surface and dries into thin crusts. The process is essentially an acute one and terminates within a few days.

Treatment of Dermatitis.—The forms of dermatitis referred to in this chapter are usually self-limited after removal of the cause. If the cause persists, it becomes a chronic process, which can be relieved, but will always show a disposition to return. When the cause cannot be readily removed, as is often the case in fecal and urinary fistula and similar conditions, much comfort will be given by palliative treatment. Foremost in importance is rigorous, absolute cleanliness and frequent removal of soiled dressings. The medicinal treatment is identical with that applied in acute eczema. Cooling lotions are always indicated— zinc oxid and lime-water ($\mathfrak{z}$j–$\mathfrak{z}$viij); the ordinary lead-and-laudanum mixture.

The diluted black wash, the decoction of white-oak bark (Duhring), or fluid extract of Grindelia robusta ($\mathfrak{z}$ij–$\mathfrak{z}$iv to rose-water 1 pint) (Hyde). After the acute symptoms have passed these applications should be supplanted by a dusting-powder, of which the simplest are the best, such, for example, as the borated starch powder or compounds of talcum, zinc oxid, magnesia, bismuth, lycopodium, etc., or soothing ointments of zinc oxid, lanolin, and cold cream should be used. In dealing with dermatitis from acrid, septic secretions a paint consisting of salicylic acid, 1 part; zinc oxid, ½ part; glycerole of starch, 100 parts, is useful. The following ointment is also useful, perhaps more than all other preparations: ℞. Zinc oxid, grams 40; prepared chalk, liq. plumb. subacetat., flaxseed oil, āā grams 20.

In the treatment of surgeon's eczema, Lassar's suggestion that the operator should change to another antiseptic will often prove valuable. In aggravated cases the suspension of surgical work is imperative; but in the milder forms it will be sufficient to resort to the following precautions in order to obtain relief. After washing the hands with water and a pure soap of good quality, or with a fatty soap such as mollin, they should be rubbed, while still damp, with equal parts of olive oil, glycerin, vaselin, and lanolin, after which kid gloves should be worn until the next operation. Rötter advises an ointment composed of formal (centigram 25–50), zinc oxid and talcum (āā 25 grams), and vaselin (50 grams). Cotton or rubber aseptic gloves should be used by operators with sensitive skins. Rhus-dermatitis must be treated with soothing lotions, first followed by powders and ointments, as the acute stage subsides.

Dermatitis Medicamentosa (*Drug-eruptions*).—Over 68 different medicinal substances are capable of producing distinct forms of dermatitis. The eruptive symptoms in these cases may result from the elimination of toxic agents through the emunctories of the skin, or by reflex action induced by irritative effects of drugs upon the mucous surface of the alimentary canal.

The commonest drug-eruptions are due to copaiba, cubebs, and, rarely, sandalwood, which give rise to a vivid erythema in patches. Arsenic, when given in full doses and for a long period of time, will cause, in addition to the well-known edematous puffiness of the lower lids, various rashes of an erythematous character; but the most typical of its effects on the skin is pigmentation of a dirty yellow or milk-and-chocolate color on the covered portions of the body and sometimes the face. Iodin and bromin and their compounds, especially potassium iodid and potassium bromid, are more often responsible for eruptions than any other class of medicinal agents. The most typical eruptions caused by potassium iodid are papulopustular, acnoid rashes, usually discrete and limited to the face, neck, shoulders, and extremities. In rarer instances, it is purpuric, vesicular, bullous, furuncular, urticarial, or nodular. The bromid salts are very similar in their effect. Quinin and other

cinchona alkaloids give rise to itching, urticaria, and erythematous eruptions. Tuberculin and the antitoxins of diphtheria, tetanus, and the streptococcus are also often followed by general erythematous and other rashes, which are attributed to imperfections in the manufacture or preservation of these agents.

Dermatitis Calorica (*Ambustio; Combustio; Burns of the Skin*); **Dermatitis Congelationis** (*Frostbite*).—The extremes of heat and cold act very much in the same manner in producing inflammatory and destructive effects upon the skin. *Chilblains* (*pernio, erythema pernio*) are skin-lesions of an erythematous type which occur chiefly upon the hands and feet, because these regions are more often exposed to the action of cold and are most distant from the centers of circulation. They are also exhibited, however, for the same reason, in other parts of the periphery (the nose, temples, cheeks, ears, and chin). They occur in the form of irregularly defined patches, slightly elevated above the general level of the surface, with a vivid hue at the periphery and the purplish aspect of passive congestion at the center. They are the seat of itching, burning, stinging, and other painful sensations, usually aggravated by warmth. They are strikingly different from other inflammations of the skin in that the surface on which they are displayed is usually cold rather than hot and insensitive.

Treatment.—Preventive.—The general indications should be met. Any dyscrasia should be treated; iron should be given if the patient is anemic: the circulation should be improved. If there is any evidence of peripheral stasis, strychnin, baths, massage, exercise, and a generous dietary are usually indicated. The feet should be thoroughly rubbed and dried until they are warm whenever the stockings or socks are removed. The feet and interdigital spaces should be dusted with boric or salicylic acid with talcum, after bathing them with spirits of camphor or alcoholic formalin solution (1 : 500), in order to ensure dryness of the surface. In all cases the circulation should be restored gradually, and not suddenly by frictions. The feet should be warmly clad; but care should be taken to avoid wearing woollen stockings and fur-lined gloves, or other material that is liable to induce sweating, as the moist skin is much more easily chilled and frost-bitten in cold weather.

The Acute Infectious Inflammations of the Skin.—For practical purposes these inflammations may be divided into the circumscribed or limited and the diffuse or progressive, in accordance with the nature of the pathogenic micro-organism that invariably causes them and the anatomical seat of the infection in the skin. The *progressive* infections are associated etiologically with the streptococcus, which preferably attacks and advances along the lymph-spaces and channels of the skin or hypoderm.

The clinical types of circumscribed inflammation vary in accordance with the original seat of the infection, which, in the skin, may be in the hair-follicles, sebaceous or coil glands, in the rete, or in the hypodermal connective tissue.

Furuncle and *carbuncle* are deeper inflammations which are especially considered in other chapters of this work (see Vol. I., Chapter III.).

Sebaceous cysts (*steatomata; wens*) are true retention-cysts, caused primarily by the obstruction of the duct of a sebaceous follicle and the accumulation of the secretions of the follicles, viz., sebaceous

matter, fat, and cholesterin crystals. Sebaceous cysts occur, often in crops, in all situations where sebaceous glands abound—scrotum, penis, and labia—and sometimes the scalp, though here the true atheromata predominate. They vary in size from that of a pea to a tangerine orange. Sebaceous cysts are liable to infection, causing suppuration and adhesion of the cyst to its surroundings. Decomposition often occurs without evidences of inflammation. Some of these cysts gradually calcify and form cutaneous stones. They may also serve as a basis for horns and epithelial cancers.

They are to be distinguished from the cutaneous *dermoids* and *atheromata* (epidermoids—Francke), with which they have many clinical affinities and for which they are often mistaken. The *dermoids* are cysts which result from the accidental inclusion of islands of skin about the embryonic branchial clefts.

Clinically, they closely resemble sebaceous cysts; but they lie deeper in the hypoderm and show no indication of external opening. Dermoids are almost invariably seated at the root of the nose, the temples, or at the terminus of the eyebrows, showing the influence of the branchial clefts in their development. When opened they contain masses of epidermal scales mixed with fine or coarse hair; their walls show the structure of the cutis, with hair-follicles and sometimes teeth, nails, and bones. The atheromata are also subcutaneous indolent tumors, from the size of a pea to that of a walnut, which distend the skin semispherically, show no opening, and contain a gritty, glittering, odorless débris, made up of epidermic scales and looking like sebaceous matter. Most of them appear in the scalp. Here they develop slowly and often multiply, showing periods of active growth alternating with a period of rest. They are, like the dermoids, inclusion-cysts that result from the accidental snaring off of epithelial cells in the hypoderm in the period of development. The atheromata differ from sebaceous cysts in the fact that they have no duct or external orifice, and in the epidermal scales which mainly constitute their contents. From the dermoids they differ in their topography, the atheromata being peculiar to the scalp; also in the adult age of the subject and in the cyst-contents, which are purely epidermal and never contain hairs or other glandular products of the skin. The pathological difference between dermoids and these atheromata is that in the former the whole skin is represented with its products in the walls of the cysts; whereas in the latter only the epidermal layer of the skin is included. Hence the name, epidermoids (Francke, Chiari, Unna). Of all these cystic formations the sebaceous are the most common.

Treatment is always by extirpation, with total removal of the cyst-walls. If this is not done, the remnants of the cysts will continue to secrete sebaceous matter. If the cyst is inflamed and suppurates, enucleation is difficult on account of adhesion to the surrounding tissue. It will be a better plan to evacuate the cyst by free incision, wash the cavity with hydrogen peroxid or formalin solution, pack with iodoform gauze, and wait for the inflammatory swelling to subside, when it will be much easier to recognize the cyst-walls and extirpate them.

Chronic Specific Infections of the Skin.—These are all characterized by the formation of inflammatory granulation-tubercles (granulomata), caused by the irritant toxic action of specific pathogenic microorganisms. Tuberculosis, syphilis, leprosy, glanders, and actinomycosis are typical representatives of this group. They are fully considered in other chapters. *Tuberculosis of the skin* is described in Chapter X., Vol. I.

Mycosis fungoides ($\mu\dot{\upsilon}\kappa\eta\varsigma$, fungus) is a disease of obscure origin and variable clinical career, which is essentially characterized by the gradual formation of red or purplish fungoid tumors, especially in the upper half of the body, unlike the sarcomata and carcinomata (which they otherwise greatly resemble) in the tendency they display to spontaneous improvement and aggravation, but finally causing death by marasmus and

sepsis. In the course of one or two years all the spots become more deeply infiltrated, and elevated tumors arise (fungoid stage). The tumors which spring from this infiltrated base attain variable dimensions, from the size of an acorn to that of a child's head. They may remain stationary for several months, and then rapidly undergo complete involution and absorption, shrivelling up and then disappearing without leaving a trace. Or they may undergo rapid ulceration, with profuse and often fetid suppuration. Secondary infection of the lymphatics almost invariably follows, the general health is undermined, and the cachectic stage sets in, followed by death.

All the cases thus far reported have ended, probably with one exception (Bazin's), fatally; and in this case spontaneous recovery followed an attack of erysipelas. The course of the disease may vary from three months to fifteen years. Its real nature is not understood, and opinions are divided as to whether the tumors should be considered as a form of sarcomatosis akin to leukemia (Funk), or as infectious granulomatous masses resulting from invasion of the skin by a specific micro-organism.

The *treatment* is purely palliative.

Frambesia (Lat., "a raspberry"), also called "yaws" and "pian," is an endemic disease of the tropics (West Indies, Africa, East Indian archipelago), of a specific chronic and constitutional character, conveyable by inoculation, and especially prevalent among the black and yellow races. The disease is characterized by an eruption, which in gradual stages matures into a fungoid type, forming raspberry-like excrescences, from which it derives its name. It affects the same patient repeatedly, and does not greatly interfere with the general health. The favorite localizations of these growths are the muco-cutaneous junctions—mouth, nose, eyes, ears, prepuce, anus—though any part of the skin may be affected.

Inoculation, which after fourteen days leads to a soft ulcer covered with a crust, is followed three or four months later by a gradually appearing eruption, with fever and general swelling of the lymphatics. The eruption first appears in the form of papules the size of mustard-seeds, which slowly extend in breadth and height, and are covered by a yellow crust with red dots. The crusty papules soon develop into tubercles; the crust falls off and exposes a papillomatous growth, which discharges a foul-smelling, sticky fluid of a dark-yellow color. "These growths are usually very resistant, preserve their form, and do not ulcerate. After reaching their fullest development, the excrescences decrease in size, grow darker, crusts fall off, and finally, after years, they disappear without leaving a scar, but only pigmented spots."

The disease has been for a long time confused with syphilis, but it is entirely a distinct, independent infection. Its essential lesion is a granuloma, caused by a specific micro-organism, probably identical with the micrococcus discovered by H. A. A. Nicholls and Numa Rat.

The *prognosis* as to ultimate recovery is good.

There is no specific *treatment*, but potassium iodid and mercury are beneficial.

A rational treatment for the local lesions would be a regular course of antiseptic baths (weak bichlorid of mercury or sulphid of potassium), with daily attention to the ulcers, the actual cautery, followed by antiseptic dusting-powders.

Yaws should not be confused with another general infection, of a grave constitutional character, which is characterized by a general eruption of a warty appearance, and known as the **verruga disease** of the Andes. It is strictly limited in its habitat to a very small area on the Pacific slope of the Andes of Peru, and is caused by a specific micro-organism somewhat like the bacillus of tuberculosis—Izquierdo's bacillus. The verruga tumors are inoculable, granulomatous formations, and not warts, in the anatomical sense of the word. It is a very dangerous, wasting affection on account of the fever, anemia, and general cachexia which accompany the long course of this disease. The prognosis is materially affected for the better by climatic changes, and especially an escape from its mountain habitat to the sea.

Mycetoma ($\mu\acute{\upsilon}\varkappa\eta\varsigma$, fungus), or **podelcoma** ($\pi o\acute{\upsilon}\varsigma$, foot ; $\check{\epsilon}\lambda\chi\omega\mu\alpha$, a sore) (*Madura foot*), is a specific parasitic affection of the feet, and more rarely of other parts (hands, scrotum, shoulder), which is endemic in India, though a few cases have been reported in the United States. (For description of this disease, see Vol. II., Chap. XXXIII.)

Oriental boil (the "endemic boil of tropical climates," variously known in different parts of the globe by topographic designations— Aleppo boil, Biskra button, Delhi boil, Pendejeh sore, etc.) is a local, painless, chronic infection of the skin, which prevails as an endemic in limited districts in warm countries, and which presents itself chiefly on the face and uncovered parts of the body (cheeks, nose, eyelids, hands, legs). It is characterized by the formation of cutaneous elevations, at first papular (like insect-bites), then nodular, of a livid-red color, which, in the average course of a year, enlarge, ulcerate, and finally cicatrize, leaving behind them indelible scars. It may appear singly or on several parts of the body. It affects mostly young people and children, especially in the autumn, at a time when many insects are about. It is an inflammatory granuloma, formed in the derm, which does not resolve spontaneously, but tends to the partial or complete destruction of the tissues in which it is developed. It is auto-inoculable, and is caused by a specific germ. The best treatment for the discrete form is excision of the entire affected area. When the boils are numerous they should be attacked in various sittings, at which a number of boils should be destroyed with a red-hot tip of the thermocautery or galvano-cautery.

Hypertrophies and Benign Neoplasms of the Skin.—Clavus (Lat., "a nail"), or **corn,** is a circumscribed callosity, usually found upon the toes, due to epidermal hypertrophy, provided with a conical plug of horny tissue beneath, which is projected into a corresponding depression in the corium. Corns are of two kinds, hard and soft. Soft corns differ only in that they occur in situations where they are kept moist and sodden by sweat and retained secretion ; for this reason they occur almost exclusively in the interdigital spaces between the toes. When an adventitious cyst or bursa forms beneath a corn, and increases so that it becomes obvious, it is called a *bunion*. A small cyst is often to be found beneath an ordinary corn of old standing and large dimensions ; but large cysts seldom form except over the meta-tarsophalangeal joint of the great toe, when this has been rendered prominent by the distortion caused by short, narrow-toed, high-heeled shoes. The bursa from time to time inflames, and the tension then occasions severe pain ; suppuration may follow from infection, but this is rare.

Treatment.—The preventive treatment is most important, and should

be directed chiefly to wearing anatomically constructed shoes. In the actual treatment of callosities and corns, the patient can be given the choice between extirpation or paring with a knife and the application of medicinal agents to soften and facilitate their decortication.

Hard corns and callosities can be softened by repeated and prolonged hot baths, followed by the application of a thick plaster of potash-soap spread over a piece of flannel, which is allowed to remain over night.

When they are soft they can be sliced off with a scalpel or pared with scissors, care being taken not to injure the papillary layer and cause a bleeding surface, for fear of infection. Another well-known plan is to use Vigier's collodium. This consists of a mixture of salicylic acid, 1 gram; ext. Cannabis Ind. fl., 50 centig; absolute alcohol, 1 gram; æther fortior, 2.5 gram; flexible collodium, 5 gram.—M. This is applied locally over the corn for at least eight consecutive nights. On the ninth day, after a hot foot-bath, the pellicle of collodium is removed, and the corn, or at least a large part, will come with it (Brocq). After the removal of the corn the surface should be protected from further pressure by an adhesive ring of felt, or by covering the site of the corn with many narrow, short, and nicely adapted strips of plaster. Soft corns require frequent bathing with hot water and soft soap, after which they are easily excised with sharp-pointed scissors or a knife. Vigier's collodium is even more effective in dealing with soft corns. The interdigital spaces should be kept dry by washing with alcohol, dusting with salicylic acid and bismuth powder, after which absorbent cotton is left in the interspaces.

Cutaneous Horns (*Cornu Cutaneum*).—These horny excrescences have only an outward resemblance to the horns of animals [except the horn of a rhinoceros, which is a huge, hard wart (keratoid)]. Their usual consistence is that of the normal nail; their color is variable, like that of any horny substance, and their length depends on the nature of the matrix and the hardness of the horn. They usually develop late in life, increase rapidly to a certain size, when their growth is spontaneously arrested or they advance more slowly. For practical purposes cutaneous horns may be divided into (1) sebaceous, (2) warty, (3) cicatricial, and (4) nail horns (J. B. Sutton). *Sebaceous horns* are most common in the seborrheic region of the forehead and head. They are formed in consequence of protrusion of the contents of a sebaceous cyst through a rupture in the cyst-wall or through the duct of a follicle which, becoming desiccated on exposure to the air, continues to increase by the addition of fresh material. In this way a horn may be produced measuring 15 cm. (6 inches). *Warty horns* closely resemble those of sebaceous origin. They occur most frequently on the penis, where they may be the starting-point of epithelioma in elderly and uncleanly persons. The only means of deciding between a warty horn and one of sebaceous origin is by dividing the attachment longitudinally and ascertaining the existence, or otherwise, of a cyst at the base of the horn.

Verrucæ or **warts** are *soft* or *hard* circumscribed elevations, due to hypertrophy of the epidermic layer of the skin. Warts have been clinically described as *papillomata*, on the theory that they were tumors formed by hypertrophy of the normal connective-tissue papillæ of the skin; but recent histological investigation has demonstrated that the lesion resides in the prickle-cell layer of the rete, which is the seat of a localized typical epithelial overgrowth, and that the apparent elongation or enlargement of the papillæ is a peculiar secondary phenomenon which plays an insignificant part in the tumor-forming process.

Verruca Vulgaris,—This most common form of wart occurs generally in young subjects—children and young adults. They occur on the hands, fingers, wrists, around the nails, more rarely on the face, almost never on the covered parts of the body. They appear also in persons whose occupation necessitates washing, cooking, or exposure to filth. Their frequent, rapid spread among children and servants and their equally sudden disappearance; their growth on cracks and fissures of the hands, after they have appeared in the neighboring skin, confirm the views held as to their contagious and inoculable character. Majocci, Cornil, and Babes have described a specific germ, the Bacillus Porri (*Porri*, warts). Kuhneman (1889) recognized a bacillus, probably the same, in the prickle-cell layer from which the warts originate.

Verruca filiformis (*fibrokeratoma*, Unna) is a name applied to very small, thread-like growths, pointed at their free extremity, which are not uncommonly seen in the eyelids, neck, and chest of old people.

Verrucæ acuminatæ or **condylomata acuminata** are the usual soft venereal warts or vegetations of the genitals. They are soft, usually moist, irregularly shaped excrescences, seated upon a normal non-infiltrated base. Their most common situation is about the junction of the skin and mucous membranes, as on the frenum of the penis, balanopreputial furrow, anus, vulva, perineum, mamma, about the mouth and cheeks, and sometimes the toe-clefts. About the genitals they grow luxuriantly and are covered with a yellowish-white puriform secretion, which has a characteristic and very disagreeable odor. When these secretions are wiped off a red vascular surface is exposed, which bleeds readily. Pregnant women are particularly liable to these growths in consequence of the abundant vaginal secretions which often attend the pregnant state. Under these circumstances they often block up the vagina and cover the entire vulva. After attaining a large size they persist for a variable time; but disappear spontaneously after delivery or after the purulent discharges which brought them into existence have been arrested. The name *condyloma*, which is also used to designate syphilitic mucous patches, often misleads students into the belief that these venereal warts of the same name are of syphilitic origin. This is an error. The soft warts under consideration are not caused by any one of the venereal viruses, but are independent growths, caused undoubtedly by a micro-organism which finds a congenital habitat in the decomposing secretions of the genitals.

Treatment of Verruca Vulgaris.—No reliance should be placed upon internal remedies, and attention should be given mainly to the *local treatment.* The most important of all local measures for all forms of warts is cleanliness. Potash-soap thoroughly rubbed in and followed by an alcoholic solution of salicylic acid or formalin (1 : 500); or, after drying the affected surfaces, painting the individual warts with a collodium composed as follows : ℞. Salicylic acid and lactic acid, *āā* 1 part, to flexible collodium, 6 parts ; or a collodium containing 1 per cent. of corrosive sublimate. The same quantity of sublimate in tincture of benzoin, and chromic acid (ʒj–ʒj) are also very effective. Any of these applications, if rigorously kept up for six or eight days, will cause the warts to shrivel and fall off. The applications may be continued until the warts are totally destroyed. The simplest and quickest way of disposing of soli-

tary or discrete warts and venereal warts is to clip them off with scissors, after cocainizing the base, and to touch the raw surface with a thermocautery.

Treatment of Verrucæ Acuminatæ.—After cutting off the warts thoroughly the base is to be cauterized with a thermocautery or with trichloracetic acid, zinc chlorid, or chromic acid in strong solutions, care being taken not to spread the caustic over the healthy skin. Before resorting to surgical treatment, it is always proper, in dealing with venereal warts especially, to try the value of simple hygienic and antiseptic measures. The main point after cleanliness with soap and water is to keep the warts as *dry* as possible and separated from mucous surfaces or contiguous warts by interposing iodoform or sublimated gauze between the affected surfaces. In washing, the following antiseptics will be found most useful if properly diluted in the local baths : Labarraque's solution ; formalin, potassium permanganate ; peroxid of hydrogen. After drying, calomel powder or salicylic acid and bismuth (1 : 3) is most useful. If these remedies fail, more energetic cauterization with saturated chromic-acid solution, trichloracetic acid, mercuric nitrate, followed by drying and calomel powder, will usually cause the warts to drop off.

Verruca filiformis and *digitata* are best treated by excision followed by touching with the caustics named or with the thermocautery. Electrolysis is a very simple and effectual method of destroying discrete, solitary warts on the face and more accessible portions of the body (Hardaway).

Molluscum epitheliale (*Molluscum*, a shell-fish), **molluscum contagiosum,** and **epithelioma molluscum** are names applied to epidermic tumors which vary in size from a mustard-seed to a pea. They are firm, roundish bodies, waxy, whitish in hue or of a dark-pink color. They are either embedded in the skin or project from it as semi-globular tubercles, sessile or pedunculated. They are either dimpled or umbilicated, and upon the top of each may be seen a dark-colored spot, from which cheesy-like contents can be extruded on pressure. These wart-like growths are usually few and isolated, rarely more than a dozen being present at one time. It is almost certain that the growths are caused by a specific microparasitic irritation.

The *treatment* is very simple. An incision into each growth, followed by forcible extrusion of the contents and touching the center of the dimple thoroughly with a caustic (silver nitrate, chromic acid, carbolic acid, thermocautery) will usually cause them to shrivel. Electrolysis is also effectual. Thorough cleanliness, washing with potash-soap, followed by inunctions of white-precipitate ointment for several days will usually suffice to prevent recurrence.

Keloid or **cheloid** (χηλη, a claw) is a term first applied by Alibert, in 1814, to designate that form of this affection which appears most often in the upper sternal region, which for a long time was supposed to originate spontaneously and without previous traumatism. At present, the belief generally entertained by pathologists is that all forms of these tumors are preceded by traumatism. The so-called spontaneous keloid is attributed to very minute surface-infections that are likely to follow itching dermatoses, especially the seborrheic affec-

tions which are common in this region of the chest. As observed by the surgeon, keloid is most often seen as a post-operative complication in the form of hypertrophied scars, or large tumors, which spring up in the cicatrices of wounds that have healed by granulation. They are of most frequent occurrence in the colored race, who are so greatly predisposed to keloids that this affection constitutes one of the most distinctive features of their racial pathology. The least traumatism involving the papillary layer of the cutis is likely to be followed by a keloid. Hence the frequency of these tumors in the ear-lobules of negroes after perforating them for ornamental purposes; also the multiple and variously sized growths following scratches, whip-lashes, blisters, burns, scalds, briar- and nettle-stings, and almost any cause or condition that will lead to vesicular or suppurative eruptions. Clinically, keloids are easily recognized by their resemblance to hypertrophied scars. They are various in size, smooth, hard, flat or plate-like, well-defined masses, which are painless and project a considerable distance above the level of the skin. Usually the size depends upon the extent of the traumatism. They grow very slowly, become paler and harder with age, and may undergo atrophic changes in old age, though this must be regarded as an exceptional occurrence.

FIG. 431.—General keloidal disease in a negro, with molluscum fibrosum.

Keloid differs clinically from simple fibroma of the skin by its elevation above the surface, its smooth cicatricial appearance, its sharp margin, its tendency to form claw-like projections which stand out in relief in the healthy skin, and finally by its tendency to recurrence after extirpation. A fully developed keloid consists of fine, dense bundles of white fibrous connective tissue which run parallel with the length of the growth and with that of the surface. Warren, in 1865, was the first to describe the origin and structure of keloid, showing that the disease has its origin in the adventitia of the vessels and the paravascular connective tissue of the cutis, to which it is strictly limited. As to its essential character, it is believed by many pathologists, with good reason, that while for the present this growth is conveniently classed with the fibromata, it will not be long before it will have to be classified with the tumors of infectious origin caused by the action of a definite microparasite, like rhinoscleroma, for instance.

Treatment is very unsatisfactory. Excision, including the entire

derm, and the covering of the surface with Thiersch's or Wolfe's grafts, have invariably failed to prevent relapse. The keloid springs up under the graft and becomes larger than before. In very small incipient keloids electrolysis will sometimes prevent further growth. Scarification and intermittent elastic compression are worse than useless; cauterization after excision in predisposed subjects is also without avail to prevent recurrence. Age alone, in the multiple keloid of negroes, appears to favor involution and sometimes the spontaneous disappearance of these growths.

Fibroma Simplex.—Simple fibroma of the skin—*i. e.,* of the derm proper—is a rare growth which appears occasionally as a solitary tumor not much larger than a marble, or less, in the upper parts of the body and extremities. It is embedded in the skin, is covered by epidermis of a normal color, and does not project beyond the surface; nor has it the waxy, scar-like appearance of keloid. It never returns after excision.

In addition to these fibromata of the cutis proper there are circumscribed, well-defined fibroids of the subjacent parts (*e. g.,* hypoderm, periosteum, fascia, nerve-trunks) which become adherent to the skin, compress it, thin it, or even grow into it, and are consequently often confused with the cutaneous fibromata. Of these, the most interesting to the surgeon are the so-called *fibroneuromata of the hypoderm,* frequently referred to, but erroneously, as painful neuroma of the skin, and, more classically still, as *painful subcutaneous tubercle.* These growths are recognized as little, hard, pea-shaped nodules in the subcutaneous tissue, between the cutis and fascia, usually on the forearm, hands, and legs, especially in the neighborhood of joints, and are very painful either spontaneously (neuralgic) or on the slightest pressure. Usually they are single, rarely multiple, always appearing in adults, especially nervous women.

While the vast majority of these growths are anything but neuromata in a histological sense, there are instances in which the tumors consist essentially of true nerve-elements. We must therefore distinguish two main forms of tuberculum dolorosum : (1) true neuromata ; and (2) a subcutaneous tumor containing nerves, which are simply distributed to the growth, but do not otherwise enter into its composition. Clinically, they cannot be distinguished, as a rule ; though there is a tendency to regard neuralgic or spontaneously painful tubercles as neuromata, and those which are only painful on pressure as fibromata, or other nerve-containing tumors.

Treatment.—The removal of these growths by excision is often followed by recurrence, the differences in this respect being due to the variable character of the growths. Nevertheless, complete extirpation is the only remedy.

Molluscum Fibrosum ; Fibroma Molluscum (Virchow); **Neurofibroma** (Recklinghausen).—These are sessile or pedunculated, soft or more firm, rounded tumors, usually distinctly circumscribed, and covered, as a rule, by normal skin.

They vary in size from a pin's head to that of an egg, but may become very much larger when they depart from the normal type, as in the pendulous form (*molluscum pendulum*),

forming huge masses weighing as much as 40 pounds or more. They may be single, but they usually appear in great numbers. In 1 case Hoshimoto (Japan) counted over 4503 tumors; in another, Ochterlony (Louisville) counted 2033; and in a case reported by the writer there were several hundred, one of which weighed 13 pounds. The smaller tumors begin as nodules beneath the skin.

According to v. Recklinghausen, these growths are formed by a proliferation of the connective-tissue sheaths of the subcutaneous nerves distributed to the skin, and therefore begin as true neurofibromata. This is followed by proliferative changes in the sheaths or the vessels, the sweat-glands, and hair-follicles. With all this there is a widespread myxomatous change in the connective tissue of the hypoderm, to which are largely due the soft, pulpy consistence of these growths and their appearance on section, which makes the name "molluscum" (mollusk) exceedingly appropriate.

There are several conditions which present relaxation of the skin with fibroid and degenerative thickening (elephantiasis), and which are often, though not always correctly, connected with the pathogeny of this disease. In these forms the integument is thrown into thick, lax, pendulous or lobulated folds, which hang like fleshy veils or mantles in various regions. A rare congenital form (*elephantiasis congenita fibrosa*), causing a uniform enlargement of the part involved, sometimes symmetrical and appearing more often in the extremities, must be distinguished from the much more frequent acquired condition known variously as *dermatolysis* (λύσις, a loosening or relaxation). *Pachydermatocele* (παχύς, thick; δέρμα, skin; κήλη, hernia or protrusion), and *cutis pendula* occur often as evolution-forms of molluscum fibrosum. These pendulous masses appear usually in the upper half of the body, especially of the face and neck, grow very slowly, and develop into pigmented, soft, elastic, and large folds of skin. At times they overlap one another, forming ruffles.

Treatment.—In all of the conditions mentioned relief can be obtained only by surgical means, and then often only in part. But the large pendulous masses which interfere with the patients' comfort and disfigure their appearance must be excised by the usual methods recommended for the extirpation of benign neoplasms. These tumors are compatible with a normal life-period.

Elephantiasis. (See also Vol. I., Chapter XXVIII.; and Vol. II., Chapter XXXIII.)

Rhinophyma (ῥίς, nose, and φῦμα, tumor) is a name given to the last stages of rosacea (seborrhœa hypertrophica), frequently but erroneously referred to as acne hypertrophica, in which the nose, perinasal portion of the cheeks, and in extreme cases the forehead and lobes of the ears are marked by a new formation of dilated blood-vessels (telangiectasis), connective-tissue hypertrophy, and enlarged sebaceous follicles, which give to the portion of the face involved a hideous, lobulated, elephantoid appearance. This condition begins as a seborrheic process which leads to a chronic hyperemia of the skin of the affected regions. In the second stage fine, tortuous, dilated vessels make their appearance. In the meantime the seborrhea is increased, and the follicular orifices become extremely dilated and fill with comedones, giving the skin a sieve-like appearance. The process commonly remains stationary in this stage, but in some cases the connective tissue undergoes progressive hypertrophic changes like elephantiasis, and rhinophyma is produced.

The *treatment* of the first and second stages is that of seborrhea, and is purely dermatological. After the third stage it is strictly surgical. For the seborrhea, frequent washing with potash-soap, shampooing the skin, followed by the application of sulphur (5 to 10 per cent.), salicylic acid (2 to 4 per cent.), resorcin, ammoniated mercury (1 to 3 per cent.) in ointment or lotion with castor oil and alcohol, will prove most effective in arresting the further progress of the disease.

When dilated vessels appear, linear scarifications (Vidal, Broca) will tend to produce anemia of the skin by cicatricial contraction. When rhinophyma exists, decortication is the only means of removing the deformity, as much healthy skin as possible being saved. When all the skin covering the lobules is too much diseased to be preserved, the entire mass should be shaved off in slices until a healthy substratum is reached. If the bleeding is profuse, pressure and thorough cauterization with the "thermo" will stop it. After healthy granulations have started, Thiersch's grafts will expedite the cure and diminish the tendency to cicatricial retraction.

Xanthoma is a lesion of the skin characterized by the appearance of yellowish or yellowish-white, usually circumscribed macules, papules, or tubercles, which occur singly or in groups, and are seen most frequently on the eyelids, but may be found occasionally on almost any portions of the skin. Three varieties of xanthoma are usually described: Xanthoma planum or palpebrarum, xanthoma tuberosum or multiplex, and xanthoma diabeticorum.

Xanthoma planum is a comparatively frequent disease of the eyelids. It occurs in small, flat papules or plates, very slightly raised above the surface of the skin, in which they lie embedded. These papules are of irregular but sharp outline, and vary in color from lemon-yellow to a chamois-leather yellow. This type of xanthoma is most frequent in women, beginning usually about the fortieth year. It is often hereditary, and occurs in family groups. The remedy is excision with a knife or scissors after cocain-anesthesia, and suture of the skin with fine catgut. Electrolysis is useful to remove the smaller patches in their incipiency. After extirpation the disease never recurs.

Xanthoma tuberosum appears in variously sized tubercular nodular lesions, pale yellowish in color, which resemble the same disease of the eyelids except in their greater development. They vary in size from that of a pin-head to a pea or larger, and in number from a few to many hundreds. They are commonly met with at points of pressure on exposed parts (buttocks, elbows, knees): they also occur in the palate, fauces, and internal organs.

Diabetic xanthoma resembles clinically the multiple variety, but it is smaller, appears more rapidly, like a papillary eruption, and often disappears very quickly without leaving a trace. It occurs in diabetic subjects, and its identity with the other forms is seriously questioned. The *treatment* of the generalized form is based on the improvement of the constitutional condition with which it is primarily associated. Morrow and Heitzmann recommend the application of 20 per cent. salicylic plaster, to be worn over the patches for several days, after which the epidermis will fall off, carrying with it a part of the yellow deposits.

Malignant Neoplasms of the Skin (*the Atypical Epithelial Growths; Epithelioma*).—All tumors or neoplasms which originate in the epithelium of the skin—*i. e.*, in the epidermic strata, the rete, the hair-follicles, the glandular appendages—and which are formed of proliferating *atypical* epithelial cells, are members of this group. As these growths originate in cells of a squamous type, in imitation of the normal epidermis, they are called squamous-cell epitheliomata, to

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distinguish them from the cylindrical-cell epithelial growths of the intestinal tract.

Clinical Classification.—Cancer of the skin may be either (1) superficial, flat, or discoid, including rodent ulcer; (2) deep-seated, nodular; (3) papillary or warty.

I. **Superficial, flat,** and **discoid** are terms applicable to all slow, indolent, and therefore comparatively benign, epidermal infiltrations that do not tend to invade the derm and hypoderm, but spread centrifugally in a horizontal plane, parallel with the basal membrane of the skin, which for a long time remains as a boundary-line between the diseased

FIG. 432.—Epithelioma of the skin.

and healthy tissue. With the exception of rodent ulcer, they may at any time be excited into active growth, and assume a rapid and most malignant character when subjected to traumatism or to other conditions, unknown to us at present, which diminish the resistance of the derm and underlying connective tissue. There are two clinical types in the group: (1) *Jacob's* or *rodent ulcer*, the most typical of the flat and discoid surface-cancers, being unique in its clinical and pathological features; (2) a group of superficial cancers which appear not only as primary nodules and flat disks in the epidermis, like incipient rodent ulcer, but are also engrafted upon various pre-existent lesions, such as fissures or erosions about the lips, old moles, nevi, or warts (that may have existed innocently for years), chronic eczematous or seborrheic

patches, so common in old men; cicatrices of former syphilitic or tubercular (lupoid) ulcers, etc.

Rodent Ulcer.—This disease shows in its very prolonged course two distinct stages, that of a year-long duration, which usually comes under the observation of the dermatologist or ophthalmologist, and a later one which comes under that of the surgeon. Rodent ulcer is invariably limited to the region of the eye. Most frequently it affects the eyelid, and a ring, 2 or 3 centimeters broad, on the forehead, temples, and cheeks. Spots that appear later are limited to a region which comprises the upper two-thirds of the face and is
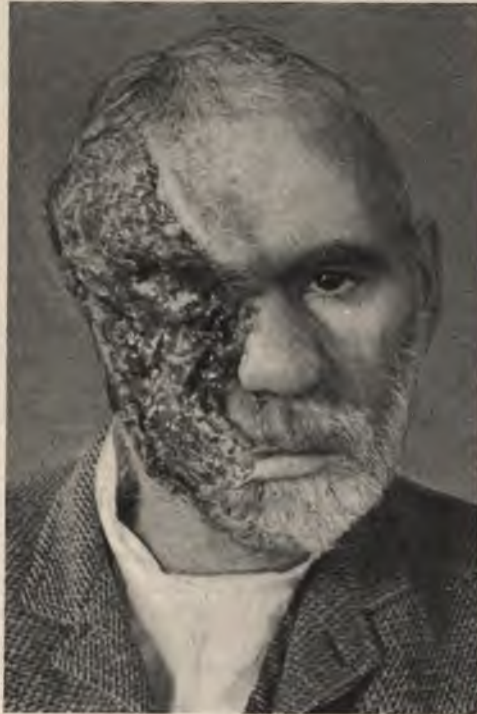
FIG. 433.—Rodent ulcer, originating in the scar from a gunshot wound of forty years' duration; no infection of the cervical glands (Warren).

margined by the hairy borders of the forehead, the ears, and a line drawn from the lobule of the ear to the mouth. Carcinoma appearing outside this region should only be thus designated with the greatest caution and when all other symptoms agree. Such cases are almost always superficial cancers of other genesis.

This cancer, as Unna accurately describes it, begins as a rosy-red or often pearly-gray, smooth nodule the size of a mustard-seed, which reaches about 1 millimeter over the surrounding level, and extends very slowly, while it sinks in the center. Thus there develop grayish-yellow or grayish-red, smooth, oval spots, from the size of a pea to that of a quarter, lying on or slightly beneath the level of the healthy skin, and surrounded by a very characteristic, fine, mother-of-pearl, ridge-like border, from which small nodular thickenings often extend. Now and then fine venous ramifications extend over the border and the center, and there is occasionally slight pigmentation. The lines of the skin are always diminished

or absent at these spots, which are striking from their smoothness and marginal shimmer. There is no distinct thickening of the skin and no peripheral inflammation. Even at this stage very slight injuries suffice to remove the cuticle, usually in the center, and there are then formed a dark crust of bloody serum and a horny layer. Left to itself, this falls off, and thus the affection gets its premature scar-like appearance. Repeated casting away of the horny layer leads to persistent ulceration, and thus commences the second, ulcerative stage.

The ulceration extends at first only to the original border, which also loses its horny layer, so that the bright-red, apparently smooth surface of the ulcer lying at the level of the healthy tissue is surrounded by a sharp, finely excavated, strikingly indifferent border, neither undermined, projecting, nor reddened. An elevated ridge, as the margin of the ulcer, exists only where the remains of the first stage are present. Later the ulcer extends very slowly. As the ulceration extends it usually affects the orbit, destroying the eye, then the malar bones and upper jaw; finally, the cancer penetrates the skull. This may take forty years or more. The ulceration always retains its benignant character: there are a fresh color, a pretty smooth, though later excavated, surface, a trivial, laudable discharge, and only slight pain and hemorrhage. The lymph-glands never swell; there is never metastasis and no cachexia. Death is due to the local destruction of vital organs or to hemorrhage (Unna).

The *histological genesis* of rodent ulcer has been the subject of much controversy and speculation, and it is still *sub judice*. Every organ of the epiderm has been incriminated; as the sweat-glands by Thin (1886), Walker (1892); the sebaceous follicles by Thiersch (1865), Butlin; hair-follicles (Tilbury Fox, Calcott Fox); the prickle-cells of the rete (Warren and Unna); any part of the epiderm (Boyce; Darrier). But whatever the primary seat of the proliferative change may be, there is no doubt, as Unna has clearly demonstrated, that the peculiar lack of infiltration and chronicity of the ulcer are explained by the structural peculiarities of the neoplasm, viz.: (1) small epithelial cylinders which have little or no capacity for downward extension, and (2) the early transformation of the vascular connective tissue, which becomes firm, fibrous, and "*cirrhotic*" in its density, thus effectively checking the downward advance of the epithelial brood-cells. The relative paucity of new epithelial cells as well as of connective-tissue new growth leads to the absence of definite tumor. A third point is also noted by Unna, and that is the almost constant displacement of the cells inside the epithelial processes, their polymorphous character, and other appearances which indicate that the cylinders are subjected to a spiral rotation, which must be ascribed to the abnormally great pressure of the hard, resisting stroma in which they are embedded.

The natural evolution of rodent ulcer is almost indefinite, whereas the other forms end life in from two to five years.

II. **The deep-seated or nodular carcinomata of the skin** may develop from downward extension of the superficial form, or they may occur primarily. They may appear as a recurrence of the disease in the cicatrices of former operations, etc. The distinctive clinical feature of the primary growths is that they infiltrate the derm and hypoderm promptly, and appear as deep dermal tumors, which become fixed, contract adhesions to the skin, show early tendency to ulceration into fungous, bleeding ulcers, and progressive infiltration of the underlying structures. They appear most commonly on the lips, back of the hand, penis, labia, cicatrices. Histologically, their cylinders form a coarse, rapidly growing network. The fungating, "reticular," "coarsely reticular," and "alveolar" types of Unna are chiefly embraced in this group.

III. **Papillary epithelioma,** also called "malignant papilloma," but erroneously, as its appearance has nothing to do with the papillæ of the skin, but is caused by the upward overgrowth and furrowing of the exuberant epithelial masses which have started in the prickle-layer and not in the papillæ. This is a very fatal form of cutaneous cancer, though in its incipiency it is more easily eradicated than the preceding forms. Its favorite seats are on the glans penis and at the junction of the mucous membrane of the lip and skin. It appears, when fully devel-

oped, like a raspberry or cauliflower excrescence, which may be pedunculated or sessile. The growth is very vascular and bleeds readily. Sooner or later ulceration occurs, deep infiltration around the base of the tumor follows, with secondary lymphatic involvement. The average duration is about four years.

Lenticular Carcinoma.—This differs from typical epitheliomata in the fact that the tumors exhibit a true alveolar structure—*i. e.*, islands or clusters of epithelial cells are snared off—cut off, as it were—from each other by an intervening connective-tissue stroma. This form is comparatively rare. It is recognized clinically, as a rule, in the female breast, as a secondary involvement of the skin over a mammary carcinoma, or in the vicinity of a cicatrix resulting from a former operation for malignant disease of the gland.

Diagnosis of Malignant Neoplasms.—The epithelial malignant neoplasms of the skin are more often mistaken for syphilitic lesions—chancre of the face and genitals, and ulcerating gummatous deposits—and for lupus and other forms of cutaneous tuberculosis, and *vice versâ*, than for other dermatoses. The deeper forms of carcinomatous disease, especially the tuberose type just mentioned, are also mistaken for sarcomatous infiltrations in the same region. In this last instance errors of diagnosis are of no grave consequence, as the prognosis and treatment are practically the same. Nevertheless, in all cases of doubt the microscopic examination of a specimen of the growth will soon differentiate between them.

From syphilitic lesions, cancer of the skin is to be distinguished by the age of the patient, syphilis being decidedly more prevalent, more common, and active in early and middle life; by the far greater relative rapidity of the syphilitic process, exception being made of tertiary gummatous ulcers of the lower extremities, which often persist for years when proper local and internal treatment is neglected; by the history of the disease in each particular instance.

Epithelioma is distinguished from lupus vulgaris, first, by the age of the patient, lupus rarely appearing after thirty-five years; epithelioma almost invariably after this age. Lupus in its early stages is more diffused than epithelioma; its elementary nodules appear separately, and not as a centrifugal homogeneous aggregation or single plane. The characteristic mother-of-pearl edge of rodent ulcer is not seen in lupus. The microscopical examination finally will settle the diagnosis.

Treatment.—All hope of radical cure must be based on the most energetic surgical local treatment. Of all the malignant growths, the cancers of the skin are most amenable to successful treatment. The key to success lies in *early diagnosis* and prompt surgical action. The failure of surgery in the majority of instances is due to the fact that the patients and their attendants are deceived by the little inconvenience caused by these growths in their incipiency, and by the fact that, owing to the superficiality and apparent insignificance of the lesions, irritative and half-way destructive topical applications are employed, and the resources of surgery are appealed to when the opportunity for successful action has passed. In each case the question that must be asked is, Can the growth be completely removed so as to include a wide zone of apparently healthy tissues in every direction? If the answer is in

the affirmative, then the knife should be used at once; and if it is possible to close the wound by sutures without tension, this should be done. But in surfaces such as the face, which are often occupied by extensive flat, discoid infiltrations, the diseased area should be extirpated *in toto* and the wound left as an open surface after *thorough, deep* cauterization with the thermocautery. The curet should never be used unless it be followed by thorough and deep cauterization with the thermocautery. In some growths it is advantageous to perform excision with the galvanocautery knife. *Caustics* may be used in pusillanimous individuals whose dread of the knife will delay any kind of treatment until the disease has become uncontrollable; sometimes also to supplement the action of the knife when the thermo- or galvanocautery is not accessible. Caustics are valuable also in dealing with extensive surface-lesions which involve great areas and penetrate to considerable depth, encroaching upon important structures which could not be thoroughly removed with the knife without great danger to life—as in advanced rodent ulcer. In persons of advanced years, or others who would be intolerant of general anesthetics, the caustic pastes can be used with advantage by one who is thoroughly conversant with their action and familiar with the results of their application.

For this purpose, Bougard's and Felix's caustic pastes are more generally applicable. Bougard's paste is made of: Wheat-flour, 60 parts; starch, 60 parts; arsenic, 1 part; cinnabar, 5 parts; sal ammoniac, 5 parts; corrosive sublimate, ½ part; 52 per cent. solution of zinc chlorid, 5 to 8 parts. The first six ingredients are separately ground and reduced to fine powder, and then mixed in a mortar of glass or china, and the solution of zinc chlorid is slowly poured in while the contents are rapidly stirred with the pestle, so as to avoid forming lumps. Felix's paste, which is not so well known, but is very efficient, owes its activity to the zinc chlorid. It contains, in addition, iodol, carbolic acid, croton chloral, and camphor bromid, but no arsenic. Caution should be observed in applying these caustics to protect the healthy skin with vaselin or other lubricant. Caustics should not be applied in proximity to the conjunctiva, as they will excite a destructive pan-ophthalmitis. The caustic pastes should be of the consistence of putty, and should be moulded with lubricated fingers to every part of the ulcerated surface. The applications should last from twelve to fifteen hours. The resulting sloughs are not detached for three or five days, during which time sedative antiseptic compresses should cover the affected area. If the first application has not been sufficiently destructive, the paste can be reapplied. In order to diminish the pain, orthoform, in proportion of 2 or 3 drams to the ounce of paste, can be applied in combination with it. As a rule, morphin, in ¼-grain doses, internally, is required at various intervals to relieve the pain, sometimes very intense, caused by the burning of the caustic. In addition to the destructive agents just mentioned a host of preparations have been recommended to check or modify the progress of the local ulcerative lesions. Prominent among these are the anilin dyes—pyoctanin (Sterling); methyl-blue (Mosetig Moorhof); potassium chlorate, in powder or saturated solution (Reclus and Hyvenand); arsenious acid suspended in alcohol (1:75) (Cerny and Trunecek); interstitial injections of alcohol (Schwalbe, Hasse and Kuh); local applications of the fluid extract of Chelidonium majus (Dennissenko), etc., are frequently referred to in recent literature, but none of these possess any really curative influence, and, as a rule, simply modify the secondary infections which complicate the cancer-process and accomplish no permanent results. Palliative operations with curet, knife, or scissors, helped by ordinary antiseptic and deodorant lotions (formalin, liq. carb. detergens, zinc chlorid, potassium permanganate, carbolic acid, cresol, chlorinated soda, Thiersch's boro-salicylic solution, etc.), are often required to remove putrid and fungating excrescences and sloughing masses whenever their offensiveness to sight and smell make them unbearable.

Dermatoses which are Closely Allied to Cancer of the Skin.—Paget's Disease of the Nipple. (See Vol. II., Chapter VII.)

Chimney-sweeps' cancer of the scrotum, first described by Percival Pott, in 1775, seems to occur almost exclusively in England. On the continent of Europe and in the United States the disease is practically

unknown by reason of greater cleanliness and by the protection afforded by the manner of dress (Butlin). The disease begins as a wart, many of which form on the scrotum, and are known as " soot-warts." They may exist for years without becoming cancerous. In the course of time one of the warts enlarges and ulcerates. The cancer spreads solely along the scrotum, being confined to the skin. In the worse cases it penetrates to the tunica vaginalis and testes. Secondary infection of the glands of the groin may occur. Internal metastases are very rare.

Tar- and Paraffin-cancer of the Skin.—This disease occurs among operatives in coal-tar and paraffin factories. These products induce great irritation of the exposed surfaces, especially of the skin of the forearm. The changes that occur in the skin resemble those of soot-cancer. The skin becomes dry, parchment-like, and in places thickened; the openings of the sebaceous glands are occluded by the tar and paraffin, producing acne-like lesions. Finally, warty outgrowths occur, which may become the seat of ulceration. The irritation of tobacco-smoke and tobacco-juice on the mucous membrane of the mouth and lips acts probably in a similar manner in predisposing to the development of cancer in the lips and oral cavity.

Cancer and Nevi (*Moles*).—The majority of these are pigmented growths, and have been attributed to sarcoma. The vast majority are true epithelial growths. The soft, button-shaped moles are normally made up of germinal cells which have separated from the epithelial cavity during fetal life or shortly after birth, forming so-called *nests*, which later in life, by traumatism or infection, are aroused into proliferative activity and end in the development of the tumors in question.

Cancer and Cicatrices.—Old scars that have been subjected to protracted irritation after middle life are liable to become cancerous. This is accounted for by the accidental inclusion of epithelial cells in the process of healing, which remain latent until roused into neoplastic activity by a protracted irritation. In all the cases referred to, it is probable that the long-continued action of irritant causes merely prepares the tissues for the action of the essential specific and still unknown agent that causes the cancer-process.

Keratosis (*κέρας*, horn).—Keratosis is a generic term employed to designate a group of diseases or conditions characterized for the most part by hypertrophic transformation of the normal epidermis of the skin into a dense and horny tissue. " Side by side with the senile, atrophic changes of the skin, but also without the latter, the skin of the aged may become harsh, dry, and unusually cornified, either diffusely or in certain definite regions, such as the hands and feet or extremities. This is the simplest form of *keratosis senilis*." In the more advanced grade the skin undergoes changes closely allied to epithelioma. The skin of the face, hands, and forearms, and less often that of the feet, legs, and genital regions of the aged, is covered with thin, horny, often greasy-looking, dark-yellowish plates or scales, between which the integument, which has undergone the atrophic changes of the senile skin, is visible. Pigmented points and maculæ may also appear scattered irregularly on the surface, with rough, dirty-yellow or brownish,

granular accumulations upon the surface of certain regions, such as the clefts, besides the alæ of the nose, temples, etc.

Treatment must be directed to the keratosis and the seborrheic state that accompanies it. The skin should be bathed daily with a soapy fat (mollin), followed occasionally by stimulating applications of green-soap. When superficial ulcerations appear under the crust, they should be thoroughly burned out with the thermocautery. In more advanced conditions excision and Bougard's paste will be required.

The Sarcomata.—The sarcomata of the skin proper, which originate in the connective tissue of the derm, have only recently attracted attention, as their relative frequency has only been established by the

FIG. 434.—Sarcoma cutis.

histological researches of the most modern dermatologists. When regarded in the light of primary neoplasms, they are all, in reality, very rare growths, especially when compared with the epithelial cancers, some of them being veritable curiosities even to dermatologists. We shall therefore merely notice the general classification of these growths without attempting to describe their clinical peculiarities or pathological characteristics, except to state that the diagnosis in many instances is entirely dependent upon careful microscopical examinations of specimens removed by operation, and that the general treatment is practically alike for all the varieties—*i. e.*, extirpation for the solitary tumors and palliative treatment in the multiple forms, which are usually

incurably fatal. There is no specific treatment. Histologically, the sarcomata of the skin, like sarcoma elsewhere, are constituted by embryonic connective-tissue cells, which may be of the round-, spindle-, or giant-cell, pigmented, melanotic, or non-pigmented type. The cutaneous sarcomata are divided into two great groups, *primary* and *secondary*—primary when they occur for the first time in the skin, and secondary when they appear as metastasis from distant or internal growths of a similar character. Either one of these forms may be solitary or multiple. We shall deal here solely with the primary sarcomata of the skin. The solitary sarcoma often presents itself as a single nodule in the derm, which persists for a long time without increase in size or ulceration. In other instances the solitary growths rapidly progress to a fatal end by regional or universal metastasis in the skin or internal organs. They are usually darkly colored, reddish-bluish, red or black tumors, now and again transparent, of the size of a pea to a cherry, and seated on the face (cheeks, eyelids), the feet, and hands, or other parts of the extremities, more rarely the trunk. They are partly compressible, bleed readily and severely when they are highly vascularized (angiosarcomata), or more firm and consistent when less vascular and of the spindle-cell variety. The long persistent, solitary sarcomata resemble in structure and behavior the infectious granulomata (*e. g.*, the gumma of syphilis and of tuberculosis) rather than ordinary sarcomata. Hence the differentiation between these conditions in the early period of their existence is extremely difficult.

Primary *multiple* sarcomata constitute a large group, and comprise all those cases which, without any pre-existent mother-growth, appear either regionally (arm, leg, face) or symmetrically (both legs, trunk) and simultaneously, as a number of individual tumors, so that a uniform development must be assumed for all.

Unna classifies them into two groups, the dermal and the hypodermal multiple sarcomata. He classifies the *dermal* in accordance with the histological formation and external type into five distinct clinical forms: 1. The multiple white and hard variety (*sarcoma multiplex cutaneum durum album*). 2. The hard pigmented form first described by Piffard (*S. multiplex cutaneum durum pigmentosum*). 3. The soft variety first described by Neuman (*S. multiplex cutaneum molle*). 4. The gummatoid (*S. multiplex cutaneum gummatoides*, Funk-Hyde type), which is distinguished from the others by the fact that the nodules rapidly reach a considerable size, then soften in the center, and discharge a gummy, semisolid material, after which they collapse and flatten out, cicatrize, and reappear again. Histologically, they are spindle-cell sarcomata which undergo myxomatous central softening. These four types of dermal sarcomata have the common feature of being irregularly scattered over the body, and do not appear in regular sequence. In this they differ from the fifth type, whose main distinction is the systematic extension of the tumors from the ends of the extremities toward the trunk. In the first forms the absence of systematic localization points to a certain indifference of the matrix. In this last there are evidently predisposing local causes for the special localization. The fifth variety is the multiple cutaneous pigmented sarcoma first described by Kaposi in 1879. It appears in the form of very dark-blue to bluish-black nodules on the hands and feet, especially on the fingers and toes and the soles of the feet. The fingers are thickened and deformed. At the ends of the extremities the nodules run together and form a painful diffuse infiltration. Then these appear on the arms and legs, advancing centripetally at the same time on the face and genitals, and, later, singly, on the trunk, isolated nodules, partly dermal, partly hypodermal, the former light reddish-brown, the latter dark and blue. With extension to the mucous membranes, which ultimately takes place, especially of the large intestine, fever and marasmus set in, and death follows after the disease has run a course of two to five years. Cases have been reported (Brayton, Hardaway) in which the disease has existed sixteen to twenty-five years. Sometimes it disappears spontaneously; in 1 case the tumors completely disappeared and

the patient recovered after the hypodermic injection of Fowler's solution applied for several months (Kobner).

The *hypodermal sarcomata* either originate in the skin—primary— or they appear as secondary metastatic nodules. The former constitute a peculiar and very rare type of round-cell tumor, which, beginning in the hypoderm, unites with the cutis, causing wine-red discoloration; it is not pigmented and attains considerable size. Much more frequent are the metastatic nodules of the hypoderm, spread over the whole body. They are secondary to primary sarcomatous growths deeper in the body and internal organs. The *hypodermal melanotic*, secondary growths are usually carcinomatous, according to Unna's recent re-searches. Nevertheless, the existence of true melanotic sarcoma in the skin, whether primary or secondary, is undeniable. The recent researches made in Gussenbauer's clinic in Vienna would seem to establish the long-suspected fact that the melanotic growths, whether epithelial or sarcomatous, are invariably associated with a specific micro-organism, to which their intense malignancy must be attributed.[1]

Trophoneurotic Lesions.— Perforating Ulcer of the Foot (*Malum, or Ulcus, Perforans*).—A typical perforating ulcer of the foot begins as a thick callosity or epidermal thickening which is situated generally under the head of the metatarsal bone of the great toe, though it may occur under any of the metatarsal heads; it is also frequent under the heel, but rarely appears in other portions of the sole. The points of election referred to are points of pressure at either end of the plantar arch. Under the callosities a spurious bursa forms, which often becomes inflamed through secondary infection and suppurates. In time traumatism leads to infection; suppuration takes place in the subepidermal tissues, and the horny layers are thrown off, leaving a deep crateriform ulcer or sinus, whose overhanging callous borders interfere with healing.

FIG. 435.—Perforating ulcer of the foot in a tabetic subject.

The granulations are either small, pale, and discharge a thin fluid secretion; or they are dark-red, uneven, ragged, and covered with foul secretions; the edges and the surrounding skin are usually anesthetic. The

[1] Roswell Park, *Amer. Jour. Med. Sci.*, May, 1898.

pain caused by inflammation is not felt, so that careless patients continue to walk upon the ulcer until perforation of the sole of the foot and septic contamination of the plantar fascia and tarsus cause constitutional symptoms and great swelling of the foot, when locomotion is interfered with and very serious surgical measures become necessary. The conditions with which it is most frequently associated are: 1. Certain central diseases, such as tabes dorsalis, syringomyelia, spina bifida, myelitis, etc., in which there is partial anesthesia or paresthesia of the plantar surfaces, which favor traumatism and infection; 2. Diseases which give rise to peripheral neuritis—syphilis, alcoholism, diabetes, leprosy, and chronic arterial disease (endarteritis, atheroma); 3. After traumatic lesions of the brain, spinal cord, and peripheral nerves, which lead to anesthesia of the soles; 4. Rarely, as a pure plantar lesion without neurotic antecedents.

In the *treatment* of this most rebellious ulcer the practitioner must aim at five things: 1. Rest, with elevation of the limb to prevent superincumbent pressure; 2. Careful antiseptic treatment of the ulcerated surface and sole of the foot, with paring of the callous edges; 3. Excision of the ulcer with its edges until healthy tissues are reached; 4. Grafting, to hasten recovery; 5. Careful protection of the heel surface with soft, well-padded soles in easy, light-covered shoes. The constitutional treatment to relieve the underlying general condition is of fundamental importance. The treatment of the peripheral neuritis should receive careful attention, and for this purpose hot and cold bathing of the extremities, with massage and electricity, are most beneficial. The recent success reported by Chipault (Paris) in the cure of this condition by stretching the posterior tibial and plantar nerves in 25 cases gives promise of more permanent results than those which have hitherto followed the classical methods of treatment. The author's experience has convinced him that grafting, especially with thick skin-grafts, is particularly useful in this class of cases, provided the patient is able to protect the grafted surfaces after healing has taken place. In aggravated cases in which the infection has spread as a purulent infiltration of the joints of the foot, amputation, partial or complete, is the only remedy.

Ainhum is a name given to a trophoneurotic affection of the foot limited to the little toe of one or both feet. It may also affect the little finger of the upper extremity, but this is exceedingly rare. Other toes may be affected besides the little toe, but this occurrence is also very exceptional. It is essentially characterized by the formation of a constriction at the digitoplantar junction, which, progressing continuously, causes a spontaneous amputation of the digit. The constriction is caused by the formation of a sclerotic band which completely encircles the toe like a tight string. The disease lasts several years, sometimes ten, before the toe drops off.

Ainhum is essentially a disease of the black races, though it is not exclusively so. It is most common among the negro population of Western Africa, South America, and West Indies, and is occasionally observed among the negroes of the Southern States. Its cause is unknown, but the trophoneurotic theory of Da Silva Lima accounts better for the symmetrical cases than any other. Leprosy will often cause a dactylitis which, in its final effects, closely resembles ainhum, but can be distinguished from it. Mason suggests that

the circular scleroderma which strangulates the toe is a fibroid change, keloidal in character, which is excited into activity by slight traumatisms and infection.

The *treatment* in the early stages consists in a complete division of the sclerotic ring; in more advanced conditions the natural amputation can be completed by a snip of the scissors.

SURGICAL DISEASES OF THE NAILS.

The nails may be congenitally absent, displaced, multiplied (super-numerary nails), or deformed. In post-natal life abnormal conditions and diseases may be acquired which will affect (1) the nail-matrix, (2) the horny nail-plate, (3) the nail-bed, and (4) the peri-ungual tissues. These parts may be separately affected, or all of them collectively may suffer; and this is the case in the traumatic and infectious diseases which begin in the subungual space and matrix.

Onychia is a name that is often used to designate any violent destructive inflammation of the nail-matrix, but it has been used specifically to distinguish a peculiar phlegmonous affection of the matrix which is most frequently observed in ill-nourished, marasmic children. The least injury to the nails (*e. g.,* chilblains) will be followed by a peri-ungual lymphangitis which is characterized by a throbbing pain, a livid, red swelling of the skin and the nail. Then a serosanguinolent exudation appears around the nail, which in turn becomes dull, opaque, or blackish in color. The nail is lifted from its bed, curves up, and is shed, leaving behind it a suppurating ulcer, which may heal slowly or invade the whole finger, causing a true whitlow, with ultimate destruction of the phalanx and digits. This lesion may appear in several fingers simultaneously.

The **treatment** consists, as in all forms of onychia of infectious origin, in removing the nail-plate, exposing and curetting all fungous, sloughing surfaces, and applying antiseptic dressings. The general condition usually demands the greatest attention; specific medication when a syphilitic taint is suspected, or antitubercular treatment, with appropriate hygiene and dietary, in strumous subjects.

Ingrown toe-nail is an affection of the great toe characterized by an inflammation of the soft parts underneath and along the side of the terminal angle of the toe-nail. It is usually acquired in adolescent and adult life. It may be internal or bilateral, involving both toes. The causes of this condition are to be found almost exclusively in tight or ill-fitting, and especially pointed shoes with high heels, which lead to overcrowding and overlapping of the toes. To this are added infrequent bathing of the feet and trimming the nail round at the corners, instead of square across. As a rule there is an overgrowth of the skin adjacent to the edge of the nail. The nail acts as a foreign body, which is constantly being pushed into the soft parts, the pressure finally causing ulceration. There are two elements to be considered: First, the overlapping inflamed soft parts; second, the overgrown horned angle of the nail. These two conditions naturally aggravate each other, but the inflamed overgrown soft parts in which the nail is buried are the chief causes of trouble.

Treatment.—The *palliative* treatment consists in keeping the soft parts well pressed back from the nail at its terminal angle and sides, and having its epithelial débris frequently removed. When the in-

dency to this condition is confirmed, some expedient must be resorted to to raise the nail from its sensitive bed and prevent the soft parts crowding over it. To-day there is nothing more simple and practical than the little appliances suggested by J. F. Taylor of New York and G. B. Webb of Colorado Springs.[1] Adhesive plaster applied so as to draw the cuticle from the edge of the nail, as suggested by Veeder and Park, of Buffalo, is very simple and also effective.

FIG. 436.—Cotting's operation for ingrown nail: 1, outline of area to be excised; 2, retracted cicatricial surface after excision of the soft parts; nail untouched.

In addition to other antiseptic applications, powdered lead nitrate is probably the best local remedy to repress exuberant granulations (Gay). The inflamed and suppurating groove is to be filled with it until healed.

The *radical surgical procedures* are innumerable. In many cases simple avulsion of the nail is insufficient; it will cure the condition for the time, but will not prevent recurrence. Cocain-anesthesia (Schleich) is all that is required for the most thorough operation, except, perhaps,

FIG. 437.—Anger's operation for ingrown nail: 1, outline of area to be excised, including nail-matrix; 2, flap formed preliminary to excision of the wedge; 3, result of operation.

in children and nervous women, when a general anesthetic may be required.

In Cotting's operation (Fig. 436) the nail is not interfered with, but all of the overlying tissues, together with the side of the toe, are sliced off freely with knife and scissors. As the wound heals the contraction of the cicatrix tends to draw the soft parts away from the edge of the nail, so that the latter is permanently prevented impinging upon the former. A Thiersch graft will hasten healing. Anger's and Quénu's

[1] *Medical News*, Dec. 23, 1899.

procedures are also very satisfactory in aggravated cases. The *rationale* of the former method is easily explained by Fig. 437.

SKIN-GRAFTING.

Grafts may be classified into: (1) *Auto-epidermic*, when they are furnished by the patient himself; (2) *hetero-epidermic*, when they are furnished by another person; (3) *zoödermic*, when the grafts are supplied by the lower species.

The zoödermic grafts have been furnished by numerous species, among which may be mentioned pieces of sponge, skin of frog, inner membrane of a hen's egg, inner surface of a pullet's wing, skin of pups, pigs, guinea-pigs, and rabbits—all of which have been experimented with more or less successfully, but are inferior to the human autodermic or heterodermic grafts. Of the heterodermic grafts, we will state that the skin of amputated stumps and other parts has been used with advantage thirty-six and ninety-six hours after amputation, and for a less time when taken from well-preserved cadavers. Of the autodermic grafts, the most elementary form consists in the scrapings of healthy skin, corn-shavings, and the pellicle of blisters. But the grafts that are now classically regarded as of practical value are dried sterile strips of epidermis obtained by vesication or accidental scalding, or Lusk's grafts; small living epidermal "pin-grafts," or Reverdin's grafts; large epidermal pieces which include a part of the cutis, Ollier, Thiersch; complete cutaneous grafts involving the entire thickness of the skin, Wolfe's grafts.

When the whole thickness of the skin is used as a graft, it can be kept after it has been detached much less time than the thin epidermal shavings used in the Thiersch method. Pure cuticle, however, obtained by vesication can be sterilized, and, if kept dry, is apparently capable of surviving as living epithelium for an indefinite length of time.

Lusk's Methods.—According to Z. J. Lusk of Warsaw, N. Y., an epidermal scale which had been kept absolutely dry and was applied in this condition was successfully grafted four hundred and eighteen days after removal from the living patient. The simplicity of Lusk's method, and the ease with which the material can be obtained by cantharides blistering or by accidental burns and scalds, would point to a large field of usefulness for it. In Lusk's method the fresh pieces of cuticle are cut off and spread over gauze pads or glass plates and sterilized in an ordinary surgical sterilizer, like any other antiseptic material. The cuticle is then dried and kept for future use. It should be applied like a scale, absolutely dry, because if moistened it will curl up and will be difficult to apply. The surfaces to be grafted should be healthy and granulating. The grafts are applied in small pieces. One piece, $\frac{1}{12}$ inch broad by 1 inch in length, can be cut into 12 sections, which should be placed on the granulating surface not more than $\frac{1}{8}$ inch apart. The grafted surface should be covered with sterilized gauze saturated with a mixture of balsam of Peru (3j in castor oil 3j), over which should be laid sterilized absorbent cotton in several layers. The dressings should not be disturbed in less than ten or fifteen days unless pus accumulates.

Reverdin's Method ("*pin-grafts*"—*introduced in 1870*).—The grafts consist of minute thin pieces of the superficial skin. The most essential condition for success is a healthy granulating surface. In suppurating wounds grafting of any kind is not applicable until active suppuration has ceased and the granulations are hard and firm. The parts from which the grafts are to be taken—preferably the outer sur-

face of the thighs or arms—should be thoroughly soaked, shaved, and disinfected with formalin solution (1 : 200) after thoroughly rubbing with ether or alcohol. The only instruments required are an ordinary long sewing-needle held in the grasp of a hemostatic forceps or a needle-holder, and a sharp scalpel or razor. Special instruments have been devised for the purpose, but they are not at all necessary. The skin is transfixed with a needle and raised to a tip like a cone; a thin epidermal shaving the size of the apex of the cone is cut off and at once transferred to the granulating surface by the needle, and in such a manner that the raw surfaces will be brought in accurate contact. The grafts are planted in rows, with small spaces between them. The entire surface may be grafted in this way or only a part of it, reserving another section for another day. As the tendency of the grafts is to curl up, care should be taken to spread them evenly with a camel's-hair pencil or gauze dipped in normal saline solution, or with the point of the needle itself. In applying these grafts the granulations should not be injured, to avoid the interposition of blood between the raw surface. No chemical germicides should be used after the granulations have been thoroughly prepared for the grafting process, as these are injurious to the grafted epithelium and interfere with firm adhesion by exciting excessive exudation. After grafting, the surface should be covered with strips of sterilized oil-silk, gutta-percha tissue, or silver-foil in an imbricated or overlapping manner. A layer of sterile gauze, followed by a copious absorbent-cotton dressing, is applied, being held in place and supported by a firm bandage. The dressings should not be removed in less than five days. If the grafts are applied while active suppuration is going on, they will, in all probability, fail to adhere, and will be floated off with the first dressing. Successful grafting is recognized by the firm adhesion of the grafts and the formation of a bluish-white pellicle around each graft-center, showing that a new zone of epidermization has developed. While Reverdin's grafts hasten the healing of ulcers very decidedly, they are inferior in this respect to the other methods that are to follow.

Ollier-Thiersch's Grafts.—This method was introduced by Ollier, of Lyons, in 1872, and perfected by Thiersch, of Leipsic, in 1874. The essential features of these grafts are that they involve half the thickness of the skin (epidermis, rete, and part of the cutis proper), and that they are cut in long strips or shavings in variable size. The vascular connections needed to nourish the grafts are established, under favorable circumstances, in eighteen hours; the new blood-vessels being sufficiently formed by this time to be injected artificially and to ensure the maintenance of enough nutrient plasma in the transplanted tissue. This method is of universal application immediately after operations when it is desirable to cover a large breach of surface, or after repair has set in, when they are used to hasten cicatrization and diminish cicatricial contraction. These grafts can be applied over connective tissue, periosteum, bone, or even fat, a granulating surface not being at all necessary for successful implantation. The technic is as follows: The skin that is to furnish the graft, preferably the hairless portion of the body (extensor surfaces of arms and thighs), is carefully prepared for twenty-four or forty-eight hours by

repeated washing and scrubbing with potash soap, hot water, alcohol, followed by lysol (1 : 400) or formalin (same proportion); it is kept covered with a moist antiseptic pad of sterilized gauze soaked in either of these solutions until the time for the operation. The surface to be grafted, if a fresh wound, is supposed to be sterile at the time of the operation; but it must be dry and free from blood. If it is an old ulcer, it must be sterilized by careful preparation, including, if it is unhealthy and callous, a complete curetting or excision of the surface and of the hard edges. If it is a healthy ulcer which has been subjected to thorough antiseptic treatment, secreting only a puruloid serum, and the granulations are small, firm, and red, no curetting or excision is required. In order to cut the grafts evenly and of sufficient length without penetrating too deeply, the skin is pinched up into a ridge, which is held and made tense at one end by an assistant, while the operator pulls upon the proximal end as the grafts are being pared with a flat razor or amputation-knife. The grafts vary from one to several inches in length and breadth, according to the size of the surface that is to be grafted. As the grafts are cut they are transferred directly from the razor or on strips of gutta-percha tissue to the raw surface; or they are floated temporarily in a basin containing neutral sterile salt solution (6 : 1000). No chemical antiseptics are to be used for irrigation over the raw surface; only sterile salt-solution is to be applied throughout the whole operation. After all bleeding is arrested and the surface is dry the grafts are applied in pieces like a mosaic, or in strips touching each other, so as to cover completely the raw surface. Great care and patience are required in adjusting the grafts to prevent the curling in of the edges. The grafts are finally pressed firmly in place with sterile gauze, after which they are covered with strips of silver foil or gutta-percha tissue, one strip overlapping the other like lattice-work. After applying a firm roller bandage over the dressings a liquid-glass or plaster roller applied over the bandage will materially aid the cure, securing immobility in the neighborhood of joints, and acting as a further protection in children. It is desirable to leave the first dressing untouched from two to five days, when the grafts will be found sufficiently adherent to stand change of dressing without injury. In grafting large surfaces it may be necessary to leave the grafts exposed to the air at the end of two or three days. The surface from which the grafts have been taken should be covered with strips of gutta-percha tissue, silver foil, or oil-silk, and covered with a regular aseptic dressing. After a few days a simple antiseptic ointment will suffice.

In Mayer's moist chamber dressing "a ring of aseptic gauze is made to encircle the limb below the grafted area and another ring above it; on these circular pads little strips of wood wrapped in sterile gauze are so laid as to make a cage, and around this cage the dressings are applied."

Wolfe's Grafts.—R. Wolfe of Glasgow in 1876 succeeded in obtaining good plastic results by covering defects about the eyelids, an inch or more in diameter, with a single piece of skin involving its whole thickness, *minus* the subcutaneous fat, which he scrupulously removed. Since then, Hirschberg and others have succeeded in transplanting solid pieces of skin without removing the fat.

Krausse's Method.—F. Krausse of Altona (1896) has perfected this complete skin-graft method in a manner that has vastly increased its field of usefulness. Krausse's grafts are made of long, unattached flaps of skin, which include the entire thickness of the derm to the fat. The graft-flaps are cut off usually from the anterior surface of the thigh, the strips of skin leaving an elongated ellipse which can readily be closed by sutures. As usual, the same precautions recommended for antiseptic preparation of the surfaces as in practising Thiersch's method must be rigorously followed. The flaps, which are cut off in the shape of a long ellipse, are carefully separated with a sharp scalpel, cutting between the derm and subcutaneous fat. After dissecting up the upper end of the flap, this is folded in so that the surface of the flap is covered as more and more of it is dissected up, the raw surfaces of the flap being protected in this way from excessive handling by the fingers. If a very small amount of adipose tissue remains, it will not interfere with the nutrition of the flap. The grafts usually shrink, immediately after

FIG. 438.—Wolfe graft borrowed from the arm to cover a defect in the lower lid after extirpation for epithelioma.

FIG. 439. — Total Wolfe graft (*g*) removed from the arm to cover denuded surface after extirpation of an epithelioma of the temple.

cutting them off, to two-thirds of their original size longitudinally, and a little less transversely, so that allowance must be made for this shrinkage. The grafts adhere closely to the prepared surface if there is no clot interposed between them. It is not necessary to suture the flap; the dressing, the same as that used for Thiersch's grafting, will usually keep it in place perfectly. The author has succeeded with this method in obtaining perfect healing and excellent cosmetic results after extirpation of nevi, epitheliomata of the face, in covering perforating ulcer of the foot, and in other localities where a more resisting skin than that furnished by Thiersch grafts was required. As a rule, the graft becomes discolored and blistered, finally losing its epidermal covering; but the deep epidermal layers and cutis remain, and these soon reproduce the lost superficial layers. The conditions for success in this method of grafting are strict asepsis throughout, dry operation, and thorough preparation of the patient and area to be covered.

Tattoo-marks; Powder-stains.—Tattoo-marks are produced by

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the introduction of various pigments (vermilion, indigo, charcoal, gun-powder, etc.) into the deeper layers of the epidermis and papillary layers, where the insoluble particles remain embedded and fixed.   To remove these, various methods have been suggested, none of which is absolutely reliable or infallible, except when small areas are to be removed.   The procedures recommended are based upon the destruc-tion, digestion, or removal by excision of the skin-areas which contain the color-granules.   Outside of caustics, chemical or electric (electroly-sis), which leave objectionable scars, the methods of Variot and Dumes-nil are to be mentioned as less objectionable.   Variot, of Paris, claims success from the following: "A concentrated solution of tannin is poured over the tattoo-marks and worked into the skin by needle-punctures in imitation of the original tattooing process.   The surface is then rubbed with a stick or solution of silver nitrate, which is allowed to act until the pink marks stand as black points, from the formation of silver tannate.   Any excess of liquid is then wiped off, and the surface treated soon turns black.   Moderate inflammation ensues; after four-teen or eighteen days the eschar drops off, leaving a reddish, superficial cicatrix, which gradually grows paler, and at the end of two months has almost disappeared.   Dumesnil, of St. Louis, has succeeded by tattooing over again with glycerol of papoid, six to ten fine cambric needles bound together being used as the implement."   In the smaller images (bracelets, shields, etc.), found on the most exposed parts, the most certain method of removal is by excision of the skin, leaving part of the corium, and covering immediately with Thiersch grafts.   Gun-powder-stains, if recent, are best removed by a careful and patient picking out of each particle or by giving the patient an anesthetic and scrub-bing the surface vigorously with a nail-brush wet with a mild antiseptic solution.   Older deposits may be treated by first washing the skin with equal parts of ammonium biniodid and distilled water, which causes the spots gradually to grow red.   The red stains are made to disappear by the application of diluted hydrochloric acid (J. B. Shoemaker).

CHAPTER XXX.

MILITARY SURGERY.

FIREARMS AND PROJECTILES.
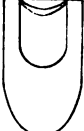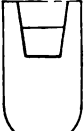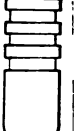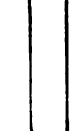
THE character of weapons and missiles with which wounds are made, as well as the surgical methods pursued in their treatment, is an important part of the study of military surgery. Without this knowledge the accumulated records of past wars lose much of their value. The nature of injuries, statistical tables, and comparisons of results must be considered in view of the weapons used and surgical treatment practised, both of which have undergone revolutionary changes in recent times. Improvement in firearms has been such as to modify the tactical handling of troops on the field and to introduce many new features into the casualties of warfare; while the application of antiseptic methods to military surgery has had a similar influence upon the treatment of wounds and the management of the wounded.

The epoch-making events which mark the principal stages in the evolution of the modern rifle may be gleaned from the accompanying scheme (Table I., page 916).

The successful elongation of the projectile in the Minié and Enfield rifles marks the first step in that rapid succession of changes which culminated in the present small-caliber magazine-rifle and breech-loading rifled cannon. The first of the new rifles brought into action on the field was at the battles of Concon and Placilla, during the civil war in Chili in 1891, when about one-half of the Constitutional forces were armed with the 8 mm. Mannlicher, while the rest of the troops on both sides used the Gras with a 10.9 mm. lead bullet. Since then they have been used by the British troops in the Chitral and other expeditions in India and Africa, by the Japanese in the war with China, by the Italians in Abyssinia, and on both sides during the Spanish-American war. In the recent war between Greece and Turkey, the Greeks were armed with the old French Gras, and the Turks principally with the Peabody-Martini of similar kind.

The superiority of the new rifle-bullet lies principally in its high sectional density, high velocity, rapid axial rotation, and great stability, which combine to produce a comparatively flat trajectory, long range, powerful striking energy, penetration, and increased accuracy. It is a compound missile, constructed with a core of lead swaged into a casing of strong metal. The lead core is hardened by 2 to 5 per cent. of tin or antimony, and the casing is usually composed of 80 parts of copper, 20 of nickel, and a fractional part of steel. To obtain high sectional density, the greatest amount of weight is combined with the smallest area of cross-section in any given length. This, with a cylindrical form and ogival

TABLE I.—*Types and Periods in the Evolution of Small Arms.*

Designation.	Bullet.			Powder, grams.	Initial velocity, meters.	Effective range, meters.	Outline of missile, two-thirds actual size.	Types and periods.
	Caliber, mm.	Metal.	Weight, gm.					
Smooth bore muzzle-loaders (1700).	19.2 to 17.6 Spherical.	Soft lead	37.6 to 31.4	18 to 23 Loose black.	180 to 230	150 to 300		I. Smooth-bore muzzle-loaders: used with the flint-lock from latter part of seventeenth century to about 1840, and afterward with percussion-cap, until they were gradually replaced by muzzle-load ng rifles, during and soon after the Crimean War (1854–1856).
Minié rifle (1851).	17.6 to 17.2 Conical.	Soft lead.	44.5 to 36.	9.8 Black.	284 to 310	600 to 1000		II. Percussion-cap muzzle-loading rifles of this type first appeared in the Crimean War, and were used in the Italian War (1859), War of the Rebellion (1861–1865), and by the Danish and Austrian troops in the war with Prussia (1864–1866).
Enfield rifle (1855).	14.5 Cylindro-conical.	Soft lead.	34.7	9.8 Black.	310	900 to 1200		
Needle-gun (1864).	13.6 Oval.	Soft lead.	31.3	4.85 Black.	300	1000 to 1500		III. Breech-loading rifles first appeared on the field in the Prussian needle-gun during the wars of 1864–ʼ866. nvented as far back as 1842. Used in Franco-German War (improved needle-gun and Chassepôt), in the Turkish War, 1877–1878 (Peabody-Martini), in the Chilean War, 1891 (Gras), and the two latter in the war between Greece and Turkey (1897).
Needle-gun (1867).	12.3 Oval.	Soft lead.	21.5	4.85 Black.	350	1000 to 1800		
Chassepôt (1866).	11.8 Cylindro-conical.	Soft lead.	25.	5.6 Black.	420	1000 to 2000		
Gras (1874).	10.9 Cylindro-conical.	Compound lead.	25.	5.25 Black.	430	1500 to 2000		
Lebel (1886).	8.19 Cylindro-ogival.	Hard lead, cupro-nickel case.	15.1	2.8 Smokeless.	600	3000 to 4000		IV. Small-caliber magazine-rifles, with compound bullet and smokeless powder: first appeared in the French Lebel in 1886. First used on the field in Chile in 1891 (Mannlicher, 8 mm.), and now generally adopted.

point, offers conditions most favorable for overcoming the resistance of air and other impediments. Stability of the bullet depends upon its tough metal envelope, which may be thin or slightly open in front to ensure rupture and increase its stopping power by deformity on impact, though this is scarcely admissible or desirable in civilized warfare.

In the *Tweedie bullet*, adapted to the Lee-Metford rifle for hunting-purposes, the lead core is left uncovered at the point, and is found to be very effective for large game, as it always ruptures, even in the soft parts, with great laceration of tissue. The new small-caliber metallic-case cartridge can be adapted alike to the rifle, carbine, machine-gun, and pistol. Its reduced size and weight, in addition to convenience of transportation, have enabled the soldier to carry a greater number in his belt, and made possible the magazine attachment for rapid fire.

Soon after the old spherical lead ball was changed to the cylindroconical form a reduction in caliber began, and continued until a point was reached where the soft metal would no longer take the grooves in the barrel without stripping. This limit was found at about 11 mm. Below that caliber no sufficient rotary motion could be imparted to the time-honored lead projectile which had made most of the wounds in warfare for centuries, and therefore some hard metal had to be adopted. Steel alone was too light; hence the compound bullet was devised, having a core of hard lead to give weight and a cupro-nickel covering to increase its firmness and make it take the grooves of the rifle. With this the reduction was continued to 8, 7, 6.5, and even 5 mm. But now a new difficulty arose. The old black powder, notwithstanding the improvements that had been made in its composition, left too much residue on combustion for these minute bores, which became foul and clogged after a few shots. This temporary check in the progress of improvement continued for several years, during which interval inventors and manufacturers were busy with the problem of adapting some new form of explosive agent to meet the requirements of the small-bore rifle. Success came at length in the production of the now well-known **smokeless powders.**

Of these, there are three principal classes. One is obtained through the action of nitric acid on vegetable fiber—the trinitrocellulose series; another, from the action of nitric acid on glycerin—the nitroglycerin series; and a third, by nitric acid and phenol—the basis of the picric-acid series. The several powerful explosives thus obtained are so combined, modified, and manipulated as to adapt them, in a safe and practical form, to military purposes. They are fired by means of a percussion fulminate, and when burned under confinement there remains little or no solid residue, the result being carbonic oxid, carbonic dioxid, nitrogen and hydrogen gases, and aqueous vapor, which, on being set free in the powder-chamber of the small-caliber rifle with the ordinary charge, exert a pressure of from 30,000 to 50,000 pounds to the square inch.

The **pistols** now in the military service of different nations have a caliber of from 8 mm. to 9.65 mm., and a lead bullet with black powder, except in France, Italy, Russia, and Switzerland, where a copper, brass, or German-silver cased bullet and smokeless powder are adopted. A new **automatic repeating-pistol** adapted to the small-caliber bullet has been perfected, and no doubt will be the military pistol of the future.

Artillery guns have followed in the same lines and with the same rapid strides of improvement as those indicated for small arms. All cannons, from the lightest mountain-field-piece to the heaviest coast-defender, including mortars and howitzers, are now rifled breech-loaders. All projectiles except canister-shot are of the cylindroconical form, and are provided with an internal cavity for a bursting charge of powder or dynamite when desirable. The tendency has been toward a steady reduction of caliber and the adoption of high-power explosives, which have resulted in vastly increased range, accuracy, mobility, rapidity of fire, and destructive effect.

EFFECTS OF RECENT CHANGES IN FIREARMS.

It is important to consider briefly what influence modern improvement in firearms will probably have in future wars upon military surgery, the casualties of battle, and the handling of wounded on the field. The vastly increased efficiency of artillery will give that arm of the service a much more prominent part than heretofore in all military operations. The light field-batteries, especially with their improved projectiles and breech-loading mechanism, their increased range, rapid fire, mobility in action, and precision, will be of greater assistance to the infantry in future. Modern field- and siege-guns have a maximum range of 8000 and 10,000 meters, respectively. The iron and steel shells can be exploded with accuracy against the enemy's material or

Shell.   Shrapnel.   Canister.

Fig. 440.—Used with 3.2 inch breech-loading rifled field-batteries.

advancing columns up to 6000 meters. Shrapnel has been greatly improved, and is now largely used with the field-guns. Recent experiments at target practice have shown that it will be very effective at from 1000 to 4000 meters, and with the new 3.2 inch gun it can be delivered in emergencies at the rate of ten shots per minute. It is a carefully adjusted, compound time-fuse shell, containing hard-lead balls and irregular disks of friable iron, and when exploded it breaks up into several hundred missiles, which are thrown forward in a cone-shaped expansion. Canister-shot is more simple and frail in construction, going to pieces by the force of ejection, but similar in effect and very destructive at short range. The result of these changes will be to increase the number of wounds made by artillery missiles, and, since these are among the more fatal injuries, to increase somewhat the percentage of mortality. The "zone of artillery fire" will be widely extended, the number of missiles

increased, and there will be greater danger and difficulty in approaching the field with wheeled transport and in finding locations at convenient distance for the hospitals and dressing-places.

The new small-caliber rifle is capable of causing a mortal wound at 4000 meters, which is nearly double the effective range of any infantry arm heretofore used.

The Chassepôt rifle inflicted severe loss on the German reserves in the battle of St. Privat at 1500 meters, and the Russian reserves met with a similar experience in front of Plevna from the Peabody-Martini rifle at 2000 meters; but with the flat trajectory and longer range of the rifle now in use such losses may occur at far greater distance. Woloz-koi,[1] Bircher,[2] and others maintain that moving troops will suffer more on the line of prob-

Fig. 441.—Penetration in oak at 3 feet from the muzzle with a 7.62 mm. rifle.

able development at 900 to 2000 meters than those lying down on the line of decisive fighting at 500 to 700 meters, and this was the experience of our troops at Santiago and Manila. The muzzle-velocity attained with the new bullet is 610 to 720 meters; that of the old is about 430 meters. This improvement has reduced the curve of the trajectory and extended the point-blank range or danger-space from 400 to nearly 600 meters, with a corresponding increase in the striking energy and penetration of the bullet. The 7 mm. Mauser bullet has at close range a somewhat greater penetration than that of the United States 7.62 mm. rifle, but at the usual fighting distance this advantage disappears.

The small size, smooth surface, sectional density, and great stability of this cupro-nickel steel-cased missile; its direct course, clean

[1] *Gewehrfeuer im Gefecht,* Darmstadt.
[2] *Untersuch. über d. Wirk. d. Handfeuerwaffen,* Aarau, 1897.

TABLE II.—*Ballistic Data of the New Small-caliber Rifles now Adopted by Different Nations.*

Army.	Rifle. Designation.	Rifle. Caliber, mm.	Bullet. Caliber, mm.	Bullet. Weight, grams.	Bullet. Length, mm.	Bullet. Structure, core, and casing.	Smokeless powder, grams.	Muzzle velocity, meters.	Muzzle energy in mkg.	Pointblank range: Inf., m.	Pointblank range: Cav., m.	Rounds in magazine.
Argentinian	Mauser, 1851.	7.65	7.89	13.7	30.7	Lead, cupro-nickel, steel.	2.64	635	...	558	640	
Austrian	Mannlicher, 1888-1890.	8.0	8.19	15.8	31.8	Hard lead, steel case.	2.74	620	309.6	466	548	5
British and Canadian	Lee-Metford, 1893. Mark II.	7.7	7.89	13.9	31.5	Hard lead, cupro-nickel.	1.97	630	320.4	503	617	8
Brazil, Chili, Mexico, Spain	Mauser, 1894-1895.	7.0	7.22	11.3	30.9	Hard lead, cupro-nickel, steel.	2.39	720	275.8	622	695	5
Danish	Krag-Jörgensen, 1889.	8.0	8.19	15.4	30.0	Lead, cupro-nickel.	2.19	620	283.2	...	608	8
French	Lebel, 1886-1893.	8.0	8.19	15.0	30.0	Hard lead, cupro-nickel.	2.79	630	305.4	515	608	8
German	Mauser, 1888.	7.9	8.10	14.7	31.25	Hard lead, cupro-nickel, steel.	2.74	640	286.1	530	594	5
Italian	Mannlicher-Carcano, 1891.	6.5	...	10.5	30.5	Hard lead, cupro-nickel.	1.97	700	262.2	...	...	5
Russian	Kapit-Mozin, 1891.	7.62	7.79	13.68	30.2	Hard lead, cupro-nickel, steel.	1.97	620	271.6	512	580	5
Roumanian	Mannlicher, 1893.	6.5	6.70	10.34	31.5	Hard lead, cupro-nickel, steel.	2.44	720	272.9	...	...	5
Swiss	Schmidt-Rubin, 1889.	7.5	8.10	13.7	31.7	Hard lead, steel point, paper jacket.	1.94	600	251.4	597	590	12
Turkish	Mauser, Belgian, 1890.	7.65	7.89	13.8	30.8	Lead, cupro-nickel.	...	653	303.4	515	608	5
United States	Krag-Jörgensen modified, 1892.	7.62	7.82	14.26	30.63	Hard lead, cupro-nickel, steel.	2.09	610	275.4	515	584	5

TABLE III.—*Percentage of Killed and Wounded to Total Strength of Combatants, and Ratio of Killed to Wounded, with the Old Smooth-bore and Improved Weapons Compared.*

I. With the Old Smooth-bore Weapons.

Killed and Wounded (per cent.)				Ratio of Mortality.			
Date.	Total strength of combatants.	Killed and wounded.	Per cent.	Date.	Killed.	Wounded.	Ratio.
Blenheim (1704) to Belle-alliance (1815): 31 great battles.	3,333,099	646,454	19.39	Blenheim (1704) to Waterloo (1815): 13 great battles.	91,732	222,699	1 to 2.43

II. With Improved Rifled and Breech-loading Weapons.

Killed and Wounded (per cent.)				Ratio of Mortality.			
Date.	Total strength of combatants.	Killed and wounded.	Per cent.	Date.	Killed.	Wounded.	Ratio.
Alma (1854) to Lizaine (1871): 32 great battles	5,270,664	542,193	10.29	Crimea (1856) to Lizaine (1871): 28 great battles.	81,331	302,171	1 to 3.96

perforation, narrow tracks, and rare lodgement or deformity in the soft parts or spongy bones, are new factors of great moment in military surgery. Where the old lead bullet stopped and flattened out, or split on the surface of bone, glanced off and lodged, or made a contour around resisting parts, the new one will pass directly through in a straight line. This would seem to indicate a greater mortality as the immediate effect of injuries, while for those who come under treatment a better prospect of recovery will be presented, owing to fewer complications and the more favorable character of wounds for the application of antiseptic measures. About 90 per cent. of the wounds of war will be made by small-caliber bullets; and as these are now practically the same in all armies, and adapted alike to the small arms and machine-guns, it is evident that the character of these injuries will be more constant and definite in future, depending for their variation mainly upon differences in distance and the tissues involved.

In view of the superior range, accuracy, and rapidity of fire attained with the arms now in use, it is believed by many that the percentage of killed and wounded, as well as the ratio of mortality, will be greatly increased in future wars. The same results have been predicted after each improvement in the past; but so far they have not been realized. Experience has shown that in the great wars of the last two centuries improvements in these weapons have not been followed by any corresponding increase in the proportion of killed and wounded. On the contrary, so far as can be learned from statistical records, there appears to have been a constant tendency in the opposite direction. As the efficiency of weapons has increased, the percentage of wounded and the ratio of mortality have, on the average, diminished, as will be seen from Table III., page 920.

It is true that on future battle-fields with the present armament a greatly extended area will be swept by a greater number of destructive missiles; but this will tend to increase the distance between contending lines, and *at long range there are fewer effective shots and a milder grade of injuries.* Troops will take advantage of every natural protection offered by the ground to cover their advance. Columns will deploy earlier and thin out into single line, advancing by "rushes" and fighting concealed, lying down so as to present as small a target to the enemy as possible. Instead of mounted men, the French have substituted *infantry for scouting purposes,* because "only well-trained infantry scouts, who profit by the smallest accidents of the ground, can creep up sufficiently close to an enemy's position to obtain reliable information and avoid surprise."[1] The Germans have organized their infantry attack: "First, to take advantage of the ground to the utmost in bringing the men within effective range of the enemy, in doing which all formations are permissible. Second, within 600 meters of the enemy to draw all supports and reserves into the firing line. Within this range only one line is exposed to fire."

As to the probable effect of **rapid fire** with the magazine-rifles, it may be said that, except at short range, it is inaccurate and wasteful of ammunition, its value depending mainly upon the moral effect.

[1] *Autumn Maneuvers,* 1894. War Department, Division of Information.

TABLE IV.

Caliber of bullet, 0.30 inch.   Weight of bullet, 220 grs.   Muzzle velocity, 2000 feet per second.   Muzzle energy $\left(\frac{M}{2}-\frac{V^2}{G}\right)$, 1964.25 foot-pounds.

Distance, yards.	End velocity, feet per second.	Striking energy, foot-pounds.	Maximum ordinate, feet.
100	1770.2	1529.2	0.18
200	1566.8	1198.0	0.45
300	1386.8	938.6	1.20
400	1229.6	737.8	3.30
500	1103.4	594.1	5.10
600	1015.9	503.7	8.40
700	932.7	442.8	12.60
800	897.7	393.3	16.50
900	848.8	351.6	24.00
1000	805.0	316.3	30.90
1500	627.3	192.0	100.80
2000	494.6	119.4	248.70

Honig states that at Mars la Tour the Germans made but 1 hit in 452 shots; and Wolozkoi estimates the percentage of hits with the new rifle at 1 to 400 shots. The number of cartridges carried by a soldier varies in different nations from 100 to 150. In the United States and England it is 100, and in France and Germany 120. From the above estimate, therefore, it would require, on a general average, all the ammunition of four soldiers to wound one of the enemy.

While the curve of the trajectory is quite low out to 600 meters, it rises rapidly beyond that point, even with the new rifle. At 1000 meters the maximum ordinate, or highest point of the arch, is 9½ meters; at 1500 meters it is above 30 meters, and on a 2000-meter range the bullet passes over a curve 76 meters high. Accuracy is difficult at such ranges, even for skilled marksmen, and with the average soldier in the excitement of battle the chances of making a hit at rapid fire would be reduced to mere accident, not to mention the rapid expenditure of cartridges and the difficulty of getting a new supply. There is little doubt that the advantages to be gained by facilitating rapid fire have been overestimated, and that the use of long ranges will neutralize much that has been acquired in precision. The magazine reserve cartridges are very effective in emergencies at *close quarters;* and while opportunities for such practice may be less frequent under the new conditions, when they do occur the number of killed and wounded with the magazine-rifle will certainly exceed that of any former weapon.

In discussing the probable effect to be expected from recent improvements in military weapons upon the percentage of wounded and the ratio of mortality, von Coler concludes that " Neither past experience nor theoretical considerations afford any sufficient basis for the supposition that the total losses in a future war will exceed former percentages so very much, as most military surgeons now seem to believe. The ratio of killed to wounded on future battle-fields will depend upon the distance at which the principal fighting takes place. Up to 600 meters the number of killed will fall very little short of the number wounded, while beyond 1000 meters the latter will greatly exceed the former."

The casualties of battle are influenced by prevailing circumstances, such as the nature of the ground—whether favorable for shelter or open; the character of the operations—whether offensive or defensive, field or siege; the number of troops engaged and the tactical skill with which they are maneuvered; the duration of the engagement; the distance between contending lines; the state of discipline among the men; defeat or victory; facilities for handling the wounded on the field, and the provisions available for their care and treatment.

GUNSHOT WOUNDS.

Gunshot wounds presented to the surgeon in civil practice are usually made by pistols, shotguns, and other domestic firearms of a light vulnerating capacity as compared with the powerful weapons now used in warfare. With the present armament wounds will be made by the small-caliber bullet and by the shells and canister of artillery. The army pistol, saber, and bayonet now in use have become obsolete as offensive weapons, but a few wounds may still be expected to result from them in quarrels and in the enforcement of discipline among the soldiers themselves.

The **proportion of wounds by different arms** in some of the later wars is recorded as follows:

War.	Small arms (per cent.).	Artillery (per cent.).	Side-arms (per cent.).
Rebellion (1861–1865)	90.1	9.8	0.37
Prussians (1866)	82.	16.	2.
Austrians and Saxons (1866)	90.	9.	1.
Germans (1870–1871)	90.4	8.	1.5
China and Japan (Third Division, Second Army Corps)[1]	90.8	7.6	1.6

In estimating the proportions of gunshot injuries that will be made by the new bullet and by artillery missiles in future battles, it may be approximately correct to allow 90 per cent. to the one and 10 per cent. to the other. Attacking parties against defensive works and those engaged in siege operations will receive a greater number of artillery wounds. At the storming of Paris the Germans lost 36 per cent. from artillery fire (Rawitz). On the other hand, in the open field, at close range, along the line of decisive action, nearly all wounds will be made with the small-caliber bullet.

The **regional distribution of gunshot wounds over the body,** found by experience in past wars, is of great interest to the military surgeon, since it furnishes definite information regarding the percentage of each class and kind of injuries, slight or severe, including fractures of the long bones, penetrations of the chest, abdomen, etc., which will occur in any given number of wounded, and thus enable him intelligently to provide beforehand means and material for his work upon the field. The records of modern wars show that this regional distribution of wounds is remarkably constant, notwithstanding many conditions and circumstances which must tend to influence

[1] Haga; Erfahr. aus japan-chin. Krieg., *Langenbeck's Archiv*, Bd. 55, H. 2, 1897.

it in the varied positions of a soldier under fire, the presence or absence of protection afforded by breastworks and other objects. The relatively large number of wounds in the hands and upper extremities in proportion to area of surface has always been observed, and seems to result from a greater exposure of those parts in the act of firing.

TABLE V.—*Distribution, Seat, Character, and Results of 245,790 Shot-injuries as they Occurred in the War of the Rebellion (1861–1865).*

Seat and character of injury.	Total number of cases.		Per cent. of frequency.		Results in cases under treatment.			
					Recoveries.	Deaths.	Undetermined results.	Per cent. of fatality.
Flesh wounds of scalp	7,739	12,089	3.14	4.9	6,573	2,676	2,840	28.9
Injuries of cranium	4,350		1.76					
Flesh wounds of face	4,914	9,416	1.99	3.82	7,406	462	1,548	5.8
Injuries of facial bones	4,502		1.83					
Flesh wounds of neck	4,895		1.99		3,496	618	781	15.0
Injuries of spine	642		0.26		279	349	14	55.5
Flesh wounds of thoracic parietes	11,549	20,264	4.69	8.23	13,921	5,373	970	27.8
Injuries of ribs	446		0.18					
Penetrating wounds of chest	8,269		3.36					
Flesh wounds of abdominal parietes	4,748	8,438	1.93	3.43	3,455	3,293	1,690	48.7
Penetrating wounds of abdomen	3,690		1.50					
Injuries of pelvis	1,494	3,159	0.60	1.27	2,194	930	35	29.7
Flesh wounds of genito-urinary organs	1,665		0.67					
Flesh wounds of back	12,681		5.15		10,883	800	998	6.9
Flesh wounds of upper extremities	54,801	87,793	22.29	35.68	80,090	5,608	2,095	6.5
Injuries of clavicle and scapula	2,280		0.92					
Injuries of bones of shoulder-joint	1,579		0.64					
Injuries of shaft of humerus	8,245		3.35					
Injuries of bones of elbow-joint	2,816		1.14					
Injuries of radius and ulna	5,194		2.11					
Injuries of bones of wrist	1,509		0.61					
Injuries of bones of hand	11,369		4.62					
Flesh wounds of lower extremities	59,139	86,413	24.06	35.15	73,665	11,813	935	13.8
Injuries of bones of hip-joint	386		0.15					
Injuries of shaft of femur	6,738		2.74					
Injuries of bones of knee-joint	3,398		1.38					
Injuries of tibia and fibula	9,171		3.73					
Injuries of bones of ankle-joint	1,722		0.70					
Injuries of bones of foot	5,859		2.39					
Aggregate	245,790		100.00		201,962	31,922	11,906	13.6

The percentage of casualties, as well as the ratio of mortality and the relation of slight to severe injuries, has varied very much in past wars. The killed have ranged from about 1 in 2 to 1 in 5; the proportion of severe wounds from one-quarter to one-half; and the slight wounds from one-half to three-quarters, while the total losses in killed and wounded have been from 15 per cent. or less to 33 per cent. of the combatant strength. With the present armament and thorough organization now common to all great armies, and as battles between civilized foes are fought with more system and discipline and at greater range, these proportions will no doubt be more definite and uniform, whether more favorable or not. At Santiago the loss from killed and wounded was approximately 10 per cent., with about 1 killed to 5 wounded.

There seems to be a general disposition on the part of authorities to assume that 20 per cent. may be taken as the probable casualties to be expected in a severe battle with the new arms. On this estimate, to every 500 combatants engaged there will be an average of 100 shot-injuries—fatal, severe, and slight. The relative proportion of the latter remains as yet a matter of conjecture, but the general location and distribution of wounds that come into the hands of the surgeon will not differ greatly from those shown in Table V., though the ultimate results will, of course, be more favorable. Among bone-

injuries, in every 100 wounded 2 or 3 compound fractures of the femur may be expected; 3 or 4 of the leg, 3 or 4 of the arm, 2 or 3 of the forearm, and 1 or 2 each of the knee and elbow-joint. Fisher says that of all shot-injuries, 21 per cent. involve the bony structures, and that, of these, 13.8 per cent. are fractures of the long bones. There will be also 1 or 2 perforating wounds of the abdomen, and 3 or 4 of the chest. The latter are much more favorable with the new bullet, and therefore a larger proportion of these wounds will come under treatment. Primary lesions to blood-vessels during the War of the Rebellion were reported in but 485 instances, and primary hemorrhage in but 110, with a total of 245,790 shot-injuries studied and tabulated. On theoretical grounds it has been assumed that hemorrhage would be more frequent from gunshot wounds with the new bullet; but in the experience so far gained from actual practice there is no evidence to confirm this assumption.

Experiments with the New Rifle.—The qualities of the new steel-cased bullet as a wound-producing missile have been very extensively studied and reported from various countries. Experiments were made on living and dead animals, and upon the human cadaver in two different ways: (1) by firing from a fixed short range with proportionately reduced charges; and (2) by full charges at normal distance out to 2000 meters. The former method has been pursued in most cases because of the difficulty of making accurate hits at the longer ranges. Results obtained at a "fixed range with reduced charges" differ very materially from those with full charge at normal distance, being more favorable, especially in injuries of the bony structure. Hence it was announced by many that wounds with the new small-caliber rifle were far less severe than those with the old, and that from a humanitarian standpoint it approached more nearly the ideal weapon, placing the greatest number hors de combat in a given time with the smallest percentage of mortality and mutilating injuries. Widely different views prevailed, however, among observers on these points, until in 1894 a thorough investigation of the subject, on a very extensive plan, was undertaken by the German War Department, under the direction of von Coler and Schjerning, the results of which are given in their elaborate and valuable report.[1] Full charges were used in actual ranges from 50 to 2000 meters, and comparative trials made with the old and new bullets. About the same time Demosthen published a series of experiments of a similar kind at Bucharest.[2] It was soon found by these observers that wounds made with full charges at normal distance were often much more severe than those with reduced charges previously reported. Skulls and bones that had shown clean perforations at 500 and 600 meters were shattered and splintered at twice that distance.

In the meantime, however, an increasing number of cases have been collected where in suicides, accidents, riots, and in war military surgeons have been able to see the effects of the new bullet on the living subject. Experience thus gained seems to indicate that a true conception of the real effects of the new bullet as they appear in actual practice has not been fully obtained from experiment. The civil war in Chile, the British campaigns in Africa and India, and a large number of cases published since the war with Spain, show that wounds of the living tissues constitute in many respects a milder type of injury than might have been inferred from the results of experiments on the cadaver. Professor Stevenson, of Netley, says: "It is now apparent that conclusions drawn from experiments made on dead animals or men are not borne out by what is observed when living men are wounded by small-caliber projectiles. It is steadily becoming more and more evident that the appalling destruction produced in dead animals and cadavers by small projectiles is not experienced when men are hit by them under ordinary conditions."[3] A large proportion of the wounds so far observed are less severe, less complicated, more amenable to treatment, and less likely to entail permanent disability than heretofore. These views will be fully confirmed when the official records of the Spanish-American War come to be published.

The **caliber of greatest effectiveness** with the new rifle seems to be at about 7 to 8 mm. A bullet within these limits appears to

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[1] *Wirkung z. Kriegschir. Bedent. der neuen Handfeuerwaffen*, Berlin, 1894.
[2] *Études expér. sur l'action du proj. cuirasse Mannlicher*, 1894.
[3] *Wounds in War*, p. 35, 1897.

combine the highest velocity and range with the greatest striking energy and wounding surface attainable with a moderate charge of powder. Increase above this would be made at the expense of velocity, and decrease, at a loss of striking energy and stopping power.

The **stability of the bullet** is an important factor in the consideration of gunshot wounds. The one now generally adopted with a cupro-nickel steel case never deforms in the tissues except on striking bone, and rarely on any but the hard parts of bone.

Von Coler and Schjerning [1] report : " In our experiments on human and animal bodies the mantled bullet was deformed only when it had to overcome the resistance of hard bone." In a total of 654 hits at 50 to 1200 meters they recovered 228 bullets, 49 of which were more or less deformed—21.5 per cent. The 49 deformed missiles were among 171 of those recovered which had struck bone, viz., 151 human bones with 37 deformities—24.5 per cent., and 20 the bones of horses, which are harder, with 12 deformities—60 per cent. Of the 37 bullets which deformed on human bone, 27 had struck compact parts of the tibia, femur, and humerus, while no less than 40 per cent. of the whole number of bullets which perforated these hard bones escaped injury. Deformities of the bullet are greatest and most frequent at the shortest ranges, diminishing with increasing distance and becoming very rare beyond 1200 meters.

Lodgement, on the contrary, is most frequent at the longer ranges, where the velocity is diminished.

Bruns never observed lodgement of the small-caliber bullet under 1200 meters. In 654 hits in human and animal tissues at all distances up to 2000 meters, von Coler and Schjerning found lodgement of the *undeformed* bullet in *direct shots* once at 1600 meters and twice at 2000 meters only. Deformed bullets lodged 3 times whole and 12 times in part. From indirect shots, however, the bullet often lodged. Complete rupture of the capsule and crushing of the lead core occur mostly at very short range, where the remaining energy is often sufficient to carry all the fragments through and out of the wound. Beyond 500 meters broken pieces are larger and ruptures less frequent, until at 1000 meters mere indentations at the point or bending of the bullet are all that is observed.

Ricochet shots, in which a projectile striking the ground, a wall, or other object rebounds, and is turned from its normal axial line or deformed, will be more frequent with the new long-range rapid-fire guns. The velocity of the missile being checked, lodgement of the whole or broken pieces may occur. Such missiles strike the body in any position—oblique, transverse, or rear-foremost—and at any rate of speed or in any state of deformity, often producing complicated lacerations especially liable to infection.

Among those wounded with the 7 mm. Mauser in front of Santiago, a considerable number of lodged bullets were found. The conditions there were favorable to indirect shots, the surface being very uneven, rocky, and covered with a thick growth of underbrush and trees. Many of the wounds were made at long range, among men far behind the firing-line. At Manila, on level ground, lodgement was rare. Reported cases show that the Mauser bullet is capable of perforating the body in almost any direction, and with perfect cartridges these bullets all have the same penetrating energy. Similar experience with the Lee-Metford rifle is reported from India.[2] Lodgement can only result from indirect shots or extended range when no hard bone is struck.

Clothing and other foreign matter are frequently carried into wounds by indirect and ricochet missiles; but the reduced caliber and polished surface of the bullet now in use are qualities which, in its integrity, make it seldom the vehicle of infecting material.

[1] *Loc. cit.*   [2] *Lancet*, Oct., 1898.

In the experiments of von Coler and Schjerning,[1] bits of the cloth covering were demonstrated in only 12 per cent. of all wounds on the cadaver ; but Delorme, Habart, and Faulhaber, after thorough investigation of this question, agree that on close inspection wound-canals of the small-caliber bullet will rarely be found free from some minute particles of woollen, cotton, or linen fiber carried in from the outer or inner clothing.

Surface-soil from certain localities adhering to ricochet missiles may in rare cases include tetanus-spores. While the removal of foreign bodies from shot-injuries is highly desirable, it is sometimes difficult or impossible. Efforts to accomplish this purpose should be carefully guarded, lest they do more harm than good. Lodgement of the new bullet within 1600 meters will be confined to indirect shots

FIG. 442.—Lodgement of the bullet. Private Jeremiah Flynn, Co. E, 6th U. S. Infantry, wounded in left arm and body at Santiago, July 1, 1898 (7 mm. Mauser), while lying down in the act of firing. Bullet shattered upper end of ulna and lower end of humerus, and, passing out of the arm, entered left side of chest, coursed downward and backward, and lodged in the lumbar region. Ankylosis of the elbow-joint.

and to injuries of hard bone. When in such cases there is difficulty in its removal, it may be safely left at least to secondary operation. Neither the lodgement of a bullet nor the presence of small particles of clothing in a wound is necessarily followed by infection. Numerous instances are recorded in surgical literature where primary union has followed injuries in which such objects were buried. At Santiago and Manila there were very few suppurating wounds, and some of these might have been prevented by more careful handling. Experience in these battles has shown that infection of wounds made by the small-caliber bullet is exceptional and usually limited to superficial parts.

The **heat of a bullet** produced by penetration varies with the distance as well as with the nature of the substance through which it

[1] *Loc. cit.*

FIG. 443.—Jeremiah Flynn, Co. E, 6th U. S. Infantry (see description of Figure 442).

passes. In pine boards at 50 meters it may reach a temperature of 159° C.; at 800 meters only 70° C. But in the human tissues the

FIG. 444.—Flesh wound; lodgement of undeformed bullet. Private Arthur C. Gardy, Co. E, 6th U. S. Infantry, flesh wound of right shoulder, Santiago, Cuba, July 1, 1898 (7 mm. Mauser); bullet lodged under skin of back, and was removed July 2.

maximum heat attained by the bullet on penetrating hard bone at short range is 95° C., or rarely a shade above. As the range is

extended, it falls to 65° C. and below according to the distance and resistance to be overcome. There is not sufficient heat produced either by friction in the barrel or by impact on animal bodies to sterilize the bullet or injure the tissues.

The amount of heat produced at rapid fire in the rifle-barrel by the new powders, however, is very considerable. Twenty-five rounds in 64 seconds raised the temperature in the barrel from 84° to 196° F.;[1] and 100 shots fired within two and one-half minutes brought the lead core of the bullet to the melting-point (334° C.).[2]

General Character of Wounds with the Small-caliber Bullet.—In addition to deflection and deformity of the bullet above considered, the principal factors which determine the character of wounds with the new rifle are (1) the physical qualities of the tissue involved and (2) the velocity of the bullet at the moment of impact. Velocity in this connection may be considered equivalent to *active energy*, which is the real agent concerned. Variations in the tissues which affect the action of the bullet are for the most part differences in density, elasticity, and the amount of liquid present either in cavities or in saturation. Velocity bears a definite and inverse relation to distance, and its effects are shown by gradual changes in the character of wounds as the distance is increased or diminished. While these changes differ in degree in different structures, and are never marked by any well-defined lines of sudden variation, it will be convenient for purposes of description to divide the distance into three principal ranges—short, within 500 meters; middle, from 500 to 1200 meters; and long, from 1200 to 2000 meters and upward. The clean perforating qualities of the small-caliber bullet as compared with the well-known lacerating effects of the old lead bullet in passing through the region of important structures was illustrated in the recent war with Spain and in South Africa[3] by many remarkable wounds through the body in various directions, from which the soldiers recovered without any very serious consequences.

Perforating Wounds.—In the soft parts, including muscular and fibrous structures generally, skin, blood-vessels, nerves, lung-tissue, and also in the thin parts of bone, the small-caliber bullet, in direct shot, at all ranges up to about 2000 meters, makes a nearly clean perforation without lodgement or deformity. The openings of entrance and exit are similar, and vary but little from the diameter of the bullet, which passes in a direct line between these two points. The punched-out appearance often described in such wounds is well marked in dead bodies, where no contraction or movement succeeds to destroy the similarity; but in living tissue it is not so apparent. The substance which occupied the bullet's course remains behind, reduced to pulp or fine particles. The tract widens a little toward the middle in long wounds through soft tissue, especially under high velocity; but allowing for muscular contractions and changes of position, its walls are comparatively smooth, with very little laceration. The conditions are favorable to healing, though also perhaps somewhat more favorable to hemorrhage than with the old lead bullet. Fasciæ are punched; tendons and aponeuroses may be punched or slit. Blood-

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[1] Ordnance report, 1894. [2] German report (*loc. cit.*).
[3] *Lancet*, December 23, 1899, p. 1754.

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vessels and nerves are often only partially divided, more rarely perforated, but never escape by being pushed aside. The chances of complication from injury to important vessels and nerves are, however, much diminished by the small diameter of the new bullet.

The wound of entrance through the skin is usually round, with rather smooth, depressed margins, and often 1 or 2 millimeters smaller —rarely larger—than the caliber of the bullet, or when the surface is struck obliquely it varies to oval or elongated ovoid. The narrow border of brown discoloration which, after a time, often appears around the wound-margins, results from detachment of the cuticle and subsequent congestion or drying of the denuded surface. The wound of exit averages a little larger than that of entrance; and as there is no support against the skin while it is being pushed outward, it gives way under tension. Thus these openings are more irregular, with ragged, everted margins, sometimes being mere stellate or even linear slits, which readily close and might be difficult to find. The diameter of the openings of entrance and exit in the skin, as well as that in the wound-canal, is influenced to some extent by the velocity of the bullet, being greater at close range, and averaging a little less as the distance increases. The least amount of lateral action of the bullet is found in perforations through healthy inflated lung, where the wound-canal is very minute when there is no complication from fragments of a splintered rib.

This class of injuries, occurring at all distances, supplemented by those in other tissues, especially in the spongy portions of bones, which appear at the longer ranges, constitute a large percentage of the wounds of war. They are among the most favorable for treatment with which the surgeon has to deal, and more so with the new than with the old bullet. The small openings, which tend to close, offer protection against infection, and under simple aseptic dressings they are disposed to heal almost as readily as subcutaneous injuries. The regions of greatest danger are about the neck, axilla, and femoral vessels, where, from hemorrhage or wounds of the trachea and other organs, serious complications may arise. The clean perforating qualities of the small-caliber as compared with the well-known lacerating effects of the old lead bullet in passing through important structures was illustrated in the recent war with Spain by many remarkable wounds through the neck and body in various directions, and from which the soldiers recovered without any very serious consequences.

Lacerated Wounds—Explosive Effect.—Gunshot wounds in the brain, the large glandular organs of the abdomen, the hollow viscera with fluid contents, and in the diaphyses of long bones are often complicated by lateral action of the bullet's energy, and present very different features from those described above. On firing through a skull from which the brain has been removed, clean perforations are made both at the point of entrance and of exit. When its normal contents are present, however, the skull, at short range, will be extensively ruptured, the brain more or less disorganized, and large pieces of the cranial vault may even be thrown out through the torn scalp to a distance of several meters, as though an explosion had occurred within. Such experiments have often been made upon the cadaver. The

effects may be illustrated by firing into metal cans filled with water, starch paste, or other soft substance well saturated with liquid. In the empty vessel clean perforations are made; but when filled, the sides are rent with violence and the contents scattered in all directions.

A bullet with the United States rifle, caliber 7.62 mm., was fired from a little height directly downward into the center of an open barrel of 60 gallons capacity, filled with water. The staves were of ¾-inch oak, bound by 6 iron hoops. Several gallons of water were thrown upward into the air, 2 of the iron hoops were ruptured, and a piece of stave 15 inches long was broken out from the middle of the cask, and other staves were fractured, as shown in the accompanying illustration (Fig. 445).

This lateral action of the bullet's energy has been called "explosive effect." It is a factor of the highest importance in gunshot injuries, and hence it has been the subject of much discussion and many

FIG. 445.—Explosive effect of a 7.62 mm. bullet fired from above downward into an open barrel filled with water.

experiments since the introduction of high-power rifles. It would not be practicable, or even profitable, to attempt in this place a résumé of the various theories that have been proposed and the long controversy that has been carried on to explain these remarkable phenomena. It is clear, however, that the so-called explosive action of the modern rifle-bullet, observed in certain tissues and under certain conditions, results from lateral transmission of the bullet's energy to parts immediately about the point of impact, and through them to other parts beyond. The occurrence of explosive effect in a wound depends upon the quality of the tissues for transmitting the bullet's energy. In the case of resisting bone it takes place through broken fragments, which are thrown with more or less violence into the surrounding parts. In liquids and in tissues saturated with them, it is transmitted from particle

to particle of the liquid, and exerted in all directions against resisting boundaries, as the skull, walls of the hollow viscera, and the capsules of large glandular organs. The incompressibility of watery fluid and the free mobility of its particles make it an excellent medium for the transmission of force. In soft wood, sponge, or inflated lung, on the contrary, the conditions are not favorable to the transmission of the bullet's energy, which, for lack of resistance, is expended in slight compression along the line of penetration. Similar conditions exist in fat, muscular, and fibrous structures, and in spongy bones. In passing through elastic bodies the bullet exerts its energy against the sides of the opening, which distend; but if the coefficient of elasticity be not overcome, they close again, leaving a small defect at the point of impact. Thus, wound-openings in the skin are often smaller than the caliber of the missile, especially in the axilla, behind the knee, and at other points where the skin is most elastic; and when the elasticity is overcome under tension, they are usually simple linear or radiating slits.

The explosive action of a bullet is in proportion to (1) its velocity, (2) striking energy, (3) area of impact, and (4) the resistance to be overcome. Hence it is that the severity of gunshot injuries and the deformity of the bullet are always greater at the shorter ranges, and decrease gradually with the increased distance. There are no sharply defined zones of explosive or other effect: the change is gradual, and must be studied separately for *each particular tissue and organ, according to its physical character.* The "explosive effect" described by authors is really of two kinds: (1) that in which the lateral action results from energy transmitted through the medium of a liquid, either pure or in saturation with soft tissues; and (2) that which results from splinters of bone hurled as secondary missiles into the surrounding parts. The extreme degrees of explosive effect occur at short range— that is, under high velocities; but under favorable conditions, as in the brain, large glandular organs, and in the shafts of long bones, it appears in gradually diminishing amount up to 1000 meters. The greater size and weight of the old lead bullet and the higher velocity of the new one are about in compensating relation for close range, so that up to 150 or 200 meters these two missiles produce very much the same explosive effect. Beyond this, the former, with its constant tendency to deformation, has a markedly greater lacerating effect; while the great stability, small size, and swift motion of the latter bring its peculiar penetrating qualities into prominence. At 500 to 1000 meters the lead bullet still has a very damaging effect on bone; but it deforms and often lodges, while the small one, even when broken, usually passes through and out of the wound, if no intervening object has been struck to deflect its course or reduce its velocity.

Hemorrhage.—Experiments on the cadaver afford very uncertain evidences as to the probable amount of hemorrhage to be expected from wounds with the small-caliber rifle. Nevertheless, experience thus far obtained from recorded cases in living subjects tends to show that the old saying, "gunshot wounds do not bleed," has been but little affected by the recent change in weapons. In past wars an average of about 1 per cent. of those wounded in battle have come under treatment with serious injury to blood-vessels; but, considering the

smaller caliber and fewer complications from lodgement and deformity with the new bullet, in future this percentage should be reduced. Partial division of vessels, however, where hemorrhage is most free, appears to be no less frequent with the new bullet than with the old. Primary hemorrhage in gunshot wounds usually presents one of two extremes: it is either very serious and, if not arrested, promptly fatal; or slight and easily controlled by compress and bandage, or practically absent. Slow, continuous hemorrhage rarely occurs except from certain wounds in the abdomen and lungs, where the conditions for its spontaneous arrest are unfavorable. When a vessel of large size is opened, fatal hemorrhage usually follows before any surgical aid is available; while smaller ones generally close spontaneously from contraction and coagulation which light compression favors. All wounds bleed more or less for a time; but primary hemorrhage of a grave character will, no doubt, continue to be rare among those who come under treatment on the battle-field. "Hemorrhage as met with in military practice will ordinarily be secondary, occasionally intermediary, almost never primary" (Conner).

In wounds from artillery missiles and in lacerations by fragments of bone blood-vessels of large size may be torn and lie for some time in a state of local shock without immediate bleeding; but delayed hemorrhage in such cases is very frequent. Among 1105 of the Japanese wounded, Haga[1] found but 12 cases of troublesome hemorrhage, all of which resulted from artillery missiles, and in all the hemorrhage was more or less delayed. Hemorrhage may be temporarily arrested by fragments of bone or ruptured bullet penetrating the walls of blood-vessels or the lung, and break out when these foreign bodies are removed or displaced during transportation of the wounded. In some rare instances the coats of blood-vessels have been contused by a passing missile so as to result in necrosis and subsequent hemorrhage, or in aneurysm. Shock and syncope are well-known causes of suppressed bleeding. When delayed primary hemorrhage is suspected, a possible injury to vessels must be considered with reference to the anatomy of the parts, the course of the bullet, and the presence or absence of shock. Secondary hemorrhage in gunshot, as in other injuries, results from suppuration, which will rarely appear before the wounded are in the hospital. One great advantage from the introduction of the new bullet is that wounds made by it are *less liable to infection* and suppuration, with all the consequences which follow such a grave complication, including secondary hemorrhage.

Shock after gunshot wounds is the same as that from other causes, except that it is more often localized for a time near the seat of injury. Shock is most frequent after perforations of the chest and abdomen, though it is sometimes entirely absent in these severe cases, while in others it may be even the cause of death.

Bogdanik reports the case of a young laborer shot in the riots at Biala with an 8 mm. Mannlicher rifle, from a distance of 75 steps, in which it is stated that the bullet passed transversely through the abdomen, below the umbilicus. The man was found dead near the place where he fell. Post-mortem showed no injury to the intestines and very little hemorrhage; hence it was concluded that he had died from *shock*.

[1] *Loc. cit.*

Pain is rarely more than slight immediately after gunshot wounds. Its absence appears to result from local shock and paralysis of the sensory nerves. But it always comes on later, and is then often very severe. Pain, like shock, is largely influenced by individual and national peculiarities, and by the mental state of depression or exhilaration which prevails at the time.

Wounds of Special Regions.—Head.—Wounds of the head with the new rifle are illustrated by a large number of reported suicides; but these are of little interest except to show in the human skull the enormous explosive action of the bullet at muzzle-velocity. Practical examples in warfare are numerous, and the effect of the new bullet in this region has been studied on the cadaver by many experimenters. Flesh-wounds from direct shot with the new rifle are clean perforations at all ranges, as in wounds of the soft parts elsewhere; but when the bullet grazes the skull there will be severe concussion and often fracture, with extensive injury to the underlying structures. There is no glancing off from the bone at short or middle range, and hence the surface of the skull may be grooved, with considerable loss of substance in one or both tables without penetration. Such injuries are usually accompanied by fissures, which may extend even to the base. The head is perforated at all distances up to almost 2000 meters, and at short range rupture of the skull in these cases is extensive. The effect diminishes gradually with increasing distance. At 1600 meters the first clean perforations appear and then become the rule, while splintering is the exception. Beyond 2000 meters lodgement of the bullet may occur.

A case is related (German report, *loc. cit.*) of a soldier accidentally wounded at 2700 meters, where the 8 mm. bullet entered over the left parietal bone, passed backward and outward, and lodged in the right lobe of the cerebellum, undeformed.

While perforating wounds of the head rarely come under treatment, a considerable number of lesser injuries from long range, and especially from indirect shots, claim attention. Among these are lacerated flesh wounds with lodgement of the whole or pieces of a deformed or ricochet bullet, most often in the temporal muscles, injury to the temporal artery, contusions and injuries of the outer table, depressed fracture of the inner table and penetrations of the cranium, as well as complications from shock, hemorrhage, and the presence of foreign bodies or infection in the wound. Uncomplicated flesh wounds of the head heal readily; but where concussion persists for some time, depressed fracture or some internal injury is usually present. In penetrating wounds spiculæ of bone and hairs are almost always carried just within the point of entrance. Lodged missiles from indirect shot may also be found there; but when they go beyond, their course may change by impingement on the inner curves of the skull, or they may lodge against the opposite side, or rebound or settle to a low level by gravity; hence the track is difficult to follow. Only the gentlest manipulations are admissible in attempting to locate or remove foreign bodies through these narrow channels in the brain. In many cases it is well to enlarge the entrance wound in the skull with a trephine for the removal of bone-splinters, etc., or to elevate a depressed fracture to facilitate also exploration and drainage. A light, flexible probe, with or without tele-

phone attachment, very thin, light forceps, and illumination with the *x*-rays may be of service. The head should be examined at a corresponding point on the opposite side for indications of the bullet, which
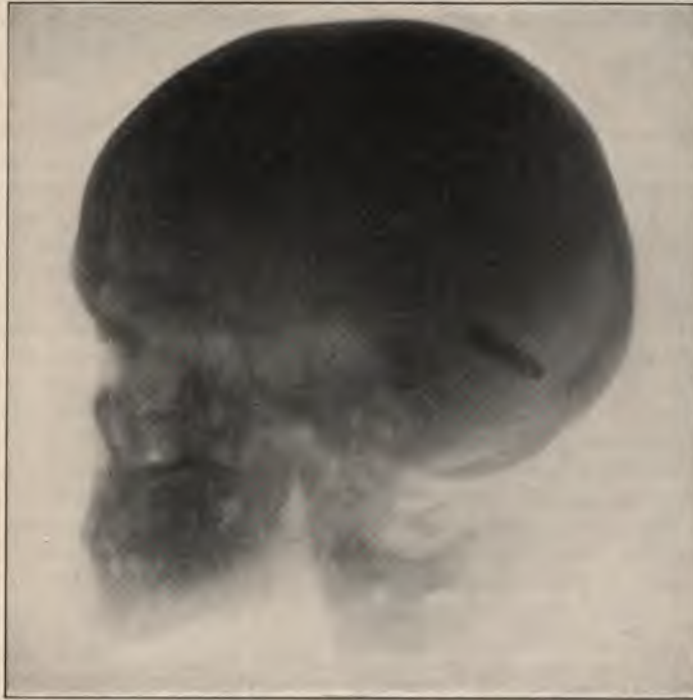
FIG. 446.—Lodgement of Mauser 7 mm. bullet (long range) in the brain. Recovery.

Private J. G., 1st Nebraska Volunteers, wounded at Mariboa, P. I., March 27, 1899. A 7 mm. bullet entered the forehead 2 centimeters above the orbital ridge and 3 centimeters to the left of the median line, passed directly backward and downward, and lodged about on the tentorium, well within the skull. He was carried one mile to a field hospital, and reached Manila twelve hours after the injury. Complete loss of consciousness for several hours; gradual return to consciousness. In bed four weeks. Primary healing of wound. Returned to quarters June 13, 1899, cured. First few days of illness were marked by severe pain in head, nausea, and vomiting. More or less pain existed for some weeks, increased by mental or physical exertion, but gradually disappeared. Returned to San Francisco with his regiment in August, quite well. Radiograph taken August 20, 1899. No history of paralysis other than a slight weakness of right arm and leg, now nearly gone. Some confusion of ideas and slowness of expression existed for a time, but no convulsions or epileptiform seizures occurred. No loss of vision of left eye, but slight ptosis, diplopia, and photophobia were present. Senses of smell and taste more acute on the right than on the left side. Reflexes active; sphincters not involved. Entered mail service, and went back to Manila on duty.

sometimes may be reached in this way through a counter-opening. Every precaution is necessary against infection, especially that of the membranes.

In 1105 of the Japanese wounded reported by Haga,[1] 157 received head-injuries. Of these, 90 were killed on the field, and 67 came under treatment where *modern antiseptic methods were practised*. Among the cases treated, 26 were injuries to the brain and membranes, and 41 flesh wounds. Of the former, 19 died and 7 were invalided; of the latter, 2 died, 3 were invalided, and 36 returned to duty.

[1] *Loc. cit.*

Face wounds with the new bullet are much more favorable than with the old deforming, lacerating lead projectile. Clean perforations are made everywhere, with very little splintering of bone, except in the lower jaw; and even there it is less than heretofore. Face wounds have two advantages—the absence of clothing as a source of infection, and free blood-supply to favor rapid healing. Lodgement in the antrum, nose, orbit, or elsewhere may occur at long range or from indirect shots.

Neck wounds are less frequent, but more dangerous, than those of the face. Injuries of the larynx and rings of the trachea are liable to complications from infection, pneumonia, contracting scars, and chronic fistulæ. Tracheotomy during the War of the Rebellion is reported in 14 cases—8 fatal, 4 discharged, and 2 returned to duty; laryngotomy, 6 cases, with 5 deaths and 1 discharge. In 4895 shot wounds of the neck, 49 involved the trachea, 37 the larynx, 18 the pharynx, and 14 the esophagus. Wounds of the nerves may cause temporary paralysis of the upper extremities; but those of the carotid vessels and spinal cord are not often brought to the surgeon. Many remarkable cases in which these organs barely escaped fatal injury with the new bullet are related in recent reports.

Chest.—In chest wounds the new bullet is much less dangerous than the old. Lodgement occurs only at very long range and from indirect shots. Fracture of the ribs is less frequent. When the large bronchi and blood-vessels at the root of the lungs are struck a fatal termination may be expected; but the vast majority of lung wounds outside of this region are clean perforations, with few complications and favorable for healing.

Habart says: "The wound-canal is smooth, and usually presents no visible lumen; but in the course of deflected bullets larger or smaller slit-like openings and guttering may appear, with free hemorrhage into the pleural sac—the usual accompaniment of lung wounds."[1] At Santiago, Colonel Senn was surprised at the number of lung wounds brought to the hospital. He says: "Unless hemorrhage was severe, the symptoms were mild, some of the patients being confined to bed only a few days." Cases were treated with simple external wound-dressings. Hemothorax was relieved by tapping.

The percentage of perforating chest wounds has been increased by the new bullet; but the mortality from these injuries, both on the field and under treatment, has been much reduced.

In a series of 22 perforating wounds of the chest reported by von Coler and Schjerning,[2] there were but 8 deaths, 7 of which were suicides, and the other 1 resulted from injury to the subclavian artery. The 14 recoveries included also no less than 8 cases of self-inflicted wounds with suicidal intent. The symptoms observed among those who recovered included sudden collapse of the lung and rush of air into the pleural cavity through the wound, and, when vessels of considerable size had been injured, hemopneumothorax followed. External bleeding occurred in some cases when the wound remained open; in others a valve-like closure was observed from sliding of the superficial tissues, and the pleural sac filled with blood. The anatomical position of wound-openings was the only determining indication as to whether bleeding came from the lung or from the chest-wall. Hemoptysis occurred in 8 of the cases, and twice it was of a light-red, frothy character. Subcutaneous emphysema appeared but twice in the 22 cases, and empyema once. The wounds remained generally aseptic, and recoveries followed in two to three weeks. Deaths were due to injuries of the heart, large bronchi, and vessels at the root of the lung. *Heart wounds* were of any extent, from clean perforations to complete rupture, according to distance and the amount of blood present at the moment of penetration.

[1] *Behandlurg der Schusswunden im Felde*, Wien, 1894.   [2] *Loc. cit.*

Complications from bone-splinters and bits of clothing are infrequent in wounds by direct shot, but they often occur with the entrance of deformed or ricochet bullets, which may themselves lodge in the chest. The greatest amount of splintering is produced at the wound of exit, where, fortunately, the fragments are carried outward away from the lung. The minute openings in the soft parts may have to be enlarged to reach loose splinters of bone or bleeding vessels, and to prevent occlusion, which, if maintained, frequently results in disastrous consequences. The diagnosis of penetration will rarely present any difficulty in wounds with the new bullet. Its course will be direct without lodgement, except at the extreme ranges or where its velocity has been spent upon some intervening object.

Abdomen.—Gunshot wounds of the abdominal viscera are among the most fatal injuries that occur in warfare. The records of past wars show that in every 100 wounded who came under treatment, an average of about 3 or 4 were hit in the abdomen, and of these about 1 or 2 had perforating wounds. Experience with the new bullet seems to indicate that the mortality from these wounds will be but little less in the future than it has been in the past. It perforates the abdomen, by direct shot, in a straight line at all but the extreme ranges. The course of the bullet indicates what structures are probably involved. In a small percentage of cases, however, the intestinal viscera escape injury. Several instances are recorded in which the small-caliber bullet has passed through the abdominal cavity, even in a transverse direction, below the umbilicus, without apparent injury to internal organs.

A case is related by Haga,[1] in the war between China and Japan, in which the bullet entered close to the umbilicus and came out at a corresponding level by the side of the spine, and the soldier speedily recovered without any unfavorable symptoms.

Visceral injuries are greater at short than at long range; but the effect of changes in distance is here less sharply marked than in other regions. Laceration from explosive effect in the large glandular organs, enormous at short range, still appears at 800 to 1000 meters; and clean perforations in the liver, spleen, and kidneys can hardly be said to occur at any range. The average size of the openings diminishes, but even at 2000 meters they are much larger than the diameter of the bullet, and the wound-canals are rough and fissures extend outward into the gland structure. Portions of disorganized liver and spleen substance may often be found lying among the coils of intestine after wounds at 600 to 800 meters. Perforation wounds in the stomach, bladder, and intestines present characters very much alike. There is no marked explosive effect, but the size of wound is influenced by the amount of fluid contents present. The stomach and bladder when filled with fluid are extensively torn on perforation at short and less so at the middle ranges. Wound-openings vary extremely in size, shape, and position, according to the course of the bullet, whether transverse, oblique, or longitudinal to the direction of the intestinal coils; whether passing through the center or only grazing the surface. An intestine perforated at right angles will show a round opening with comparatively smooth margins; while if the bullet passes nearly in the direc-

[1] *Loc. cit.*

tion of its long axis, the openings will appear oval, elongated, stellate, or torn. The size varies from 8 to 50 mm., or even much larger in diameter. The openings of entrance average a little less than those of exit, and neither are much influenced by distance under 1000 meters. Beyond 1200 meters clean perforations begin to be the rule. The number of perforations by a single shot varies from 1 to 12 or more, and averages about 3.

The relative frequency with which the different abdominal organs are struck was noted by von Coler and Schjerning in 60 perforating shots on live animals and cadavers as follows: intestines, 29; liver, 24; stomach, 19; spleen, 5; kidneys, 3; and bladder, 1. Intestinal contents escaped into the peritoneum in 20 per cent. of all intestinal wounds. In 7 cases the mucous membrane protruded at the margin, and sometimes seemed to occlude the opening. In oblique perforations, lateral displacement of the mucous and serous coats sometimes tended to form a valve-like closure of the defect. At the wound of entrance the mucous membrane was fissured for some distance, and sometimes stripped off from the other coats for 3 or 4 cm. around the margins.

The direct course of the new bullet simplifies the diagnosis of perforation, which is more difficult in wounds made by pistol-shot or by

FIG. 447.—Types of gunshot fracture in the long bones.

indirect and deformed projectiles. The great mortality after gunshot wounds of the abdomen is due to septic peritonitis and hemorrhage. The latter is found most frequently in the mesenteric veins and arteries.

Any successful operative interference is often impracticable in time of war. Four laparotomies for gunshot wounds of the abdomen at Santiago were all unsuccessful. At Manila, however, two operations were performed, with recovery in both cases. Colonel Senn saw a number of men with perforating wounds of the abdomen at a division hospital in Cuba, who were in a fair way to recovery without operation.[1]

Bones and Joints.—The severity of injuries in these parts varies greatly with the location of the wound, the density of the bone, and the velocity and size of the missile. When the small-caliber bullet passes through *spongy bone* the soft cancellated structure yields to pressure, and does not transmit the striking energy in a lateral direc-

[1] *Journ. Am. Med. Assoc.*, Nov., 1898.

tion to produce much explosive effect; but in hard bones—the malar, submaxillary, petrous portion of the temporal, olecranon process of the ulna, and especially in the diaphyses of the long bones—the action is far more destructive. At short range the bone is broken into many fragments and fissured for some distance, amounting in extent on an average of from 10 to 12 cm. in the shafts of the tibia and femur to 8 or 9 cm. in the humerus. The bone-splinters are comparatively small and numerous, and many are torn from their periosteal and muscular attachments, or even thrown out through the large irregular wound of exit. From the surface to the bone a clean perforation is made in the soft parts, but beyond the fracture there is an area, more or less extensive, in which the tissues are lacerated by flying splinters of bone, and fine bone-sand is found everywhere mingled with the shreds of muscle, fascia, and injured nerves and vessels.

With increasing distance the severity of the wound gradually diminishes; the pieces of bone are found to be larger, less numerous, and more adherent to the muscles and periosteum. Lines of fracture which at first were irregular and without definite system, now begin to assume the typical forms pointed out by Bornhaupt and Delorme. Radiating from the point of penetration obliquely upward and downward on either side at an angle of from 20 degrees to 35 degrees toward the periphery of the shaft, the four principal lines of fissure appear, and when the bone is struck in the center of its transverse diameter they are often very symmetrical. Three, two, or only one of these principal fissures may be present, according as the shot falls more or less on either side of the axis of the shaft. In lateral and tangential shots the bone may be broken by one oblique line upward or downward to the opposite side, or a piece may be split off through two such lines on the same side. Illumination with the *x*-rays has now become a valuable and indispensable aid in the examination of fractured bones, and a complete *x*-ray apparatus should form part of the equipment in every field hospital.

At 300 to 500 meters the bone remains adherent to the periosteum toward the wound of entrance, loose pieces are few, displacement is less, the area of laceration and débris beyond the fracture is much reduced, and the exit wound is smaller, not exceeding 2 or 3 cm. At 1000 meters the broken bone, except very small fragments, remains in place, and the periosteum is not often ruptured over the lines of fissure, which are not much reduced in *length*. At 1600 meters the bullet may lodge in the bone, but not as a rule. Typical perforations in the diaphyses are not to be expected at any range. Fig. 448 shows the amount of splintering and displacement of fragments in two shot fractures through the tibia and fibula made at short range on a freshly amputated limb with the U. S. 7.62 mm. rifle. The displacements here are very limited, and even these were no doubt increased from subsequent manipulations by the photographer and others.

Sometimes the periosteal membrane remains unruptured over all the longer fissures, and holds the larger fragments in place, so that it is difficult at first to determine whether or not complete fracture exists. An experimental shot through the front of the tibia, a little off the median line, made a long oblique fissure extending upward to the opposite side, and a short transverse break at the point of

FIG. 448.—Skiagraph of gunshot fracture of tibia and fibula. U. S. 7.62 mm. rifle at 10 meters' distance.

perforation. There was no displacement and no external appearance of fracture, and it was not until after the specimen had been subjected to considerable rough handling that any movement of the bone was elicited. The great difficulty with gunshot fractures on the

field is to prevent further injury from displacements of the broken bone immediately after the wound has been received and during transportation to hospital. In falling or attempting to rise or walk, or in being carried by others, periosteal coverings may be ruptured, splinters loosened and displaced, and the gravity of the injury greatly increased.

Soft Bones.—Within 200 meters clean perforations in soft bone or in the spongy ends of the long bones are rare. The entrance-wound corresponds to the caliber of the bullet; that of exit, two or three times larger. When the bone is struck in the middle line, complete fracture is usual; if to one side, the break may be only lateral. The
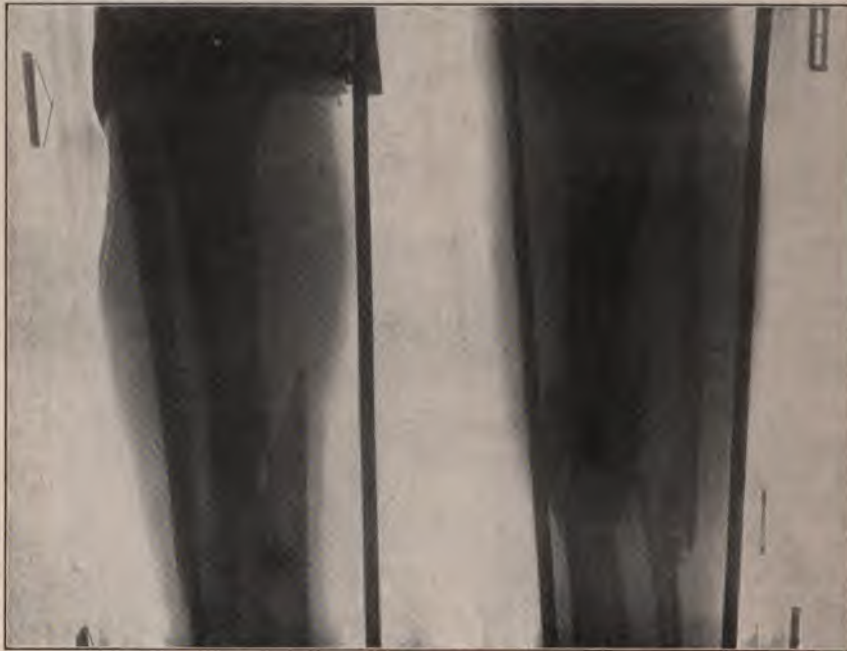
FIG. 449.—Pistol-shot wounds of both legs. Bullets allowed to remain, the wounds of entrance being tested from time to time for bacteria. Healing without suppuration.

pieces are few—about two or three—the fissures are short and the periosteum and soft parts remain attached, except perhaps on the side of exit, toward which some small fragments and particles of bone are carried into the tissues. These effects are still seen in a less degree at 600 meters; but here, under favorable conditions, clean perforations begin to appear, and beyond 800 meters they become the rule and splintering the exception, depending upon the size and hardness of the bone.

In Figs. 450–452 are shown the wounds of entrance and exit of a shot with the U S. 7.62 mm. rifle through the middle of the astragalus, from within outward. The skin-openings were small, round, and differed but little in size (5 to 7 mm.). There was no deformity or external evidence of injury to the bone; but on exposing the ankle-joint the astragalus presented a mere shell broken in two or three pieces, with the cancellated structure shaken up and lying loose in the interior. Fissures opened into the surrounding articulations, but there was no displacement, and in the live subject, under rest and aseptic dressings, the parts would no doubt have healed with little impairment of function.

A parallel case is reported by Gorgas:[1] A soldier accidentally shot himself with the U. S. 7.62-mm. rifle, June 30, 1896, the bullet passing directly through the left tarsus. Entrance, 2 inches anterior to the internal malleolus; exit, 2 inches behind the metatarso-phalangeal joint in the median line of the sole. Skin wounds much alike—diameter of lead-pencil. Examination under ether indicated clean perforation, as though the probe were being passed through a bony canal. The first dressing was changed at the end of three weeks; wound nearly healed. Soldier returned to duty entirely well Sept. 25, 1896.

In the articular ends of the large bones clean perforation is the rule, except at close range, when there are more or less comminution of the cancellated structure and detachment of the cartilage, but no fissuring or displacement, as shown in Fig. 454. The heads of

FIGS. 450–452.—Gunshot wounds, 7.62 mm. rifle at 10 meters' distance; openings of entrance and exit.

the femur and humerus are split in two or three pieces by central shots; but nearer the surface the bone is often grooved or even tunnelled without splitting. The bones about the elbow are harder, and some splintering is likely to occur; but clean perforations and rapid primary union at this joint are reported from Chile, from the Chitral campaign, and elsewhere.

From a considerable number of reported cases, it is evident that with the new bullet, gunshot wounds in soft bone and in the joints are much more favorable, from a surgical point of view, than with the old

[1] *Annual Report Surgeon-General*, 1897.

lead bullet, and that these injuries are less severe in living subjects than might be expected from experiments on the cadaver.

A case reported by Girard[1] is of great interest in this connection, and furnishes a rare specimen, here illustrated in Fig. 455. A soldier was accidentally shot through the left tibia with the United States 7.62 mm. carbine at 5 or 6 meters' distance, July 12, 1896. The ball entered on the inner surface of the tibia, 2 inches above the ankle-joint, and passed slightly downward, forward, and outward through the bone. The wound remained aseptic, healed rapidly, and the soldier returned to duty September 7, 1896. February 22,

FIG. 453.—Skiagraph of Figs. 450 and 451. Bullet passed through second metatarsal bone, fracturing the third and fourth by lateral action of the fragments.

1897, this same man fell down stairs, fractured his skull, and died. Close inspection of the specimen obtained at the post-mortem shows no evidence of anything but a clean perforation ; but according to all past experience in gunshot wounds on the cadaver, there should have been fracture and splintering of the tibia in this case at 6 meters, whether in hard or soft bone.

Wounds of the new artillery missiles will not differ from those of the old, with which military surgeons are familiar, and which

[1] *Annual Report Surgeon-General*, 1897 ; specimen in Army Med. Museum.

are so fully described in the *Surgical History of the War of the Rebellion*, the war of 1870–1871, and other works; but they will be some-

FIG. 454.—Wounds of entrance and exit in soft bone; 7.62 mm. bullet, 10 meters' distance.

what more numerous in future. The principal difficulty with this class of contused, and often large, lacerated injuries will be to keep them free from infection and suppuration, to which they are especially liable.

The **old army revolver** is obsolete as a weapon of war, but a new automatic repeating pistol, with a small-caliber steel-cased bullet, is already coming into use. Experiments with the Mauser pattern, cal-

FIG. 455.—Clean perforation of lower third of the tibia; 7.62 mm. carbine at 6 meters' distance; living subject. Death from accident seven and a third months after injury. *A*, exit; *B*, bullet; *C*, entrance.

iber 7.63 mm., are reported by von Bruns,[1] 1897. He found the weapon accurate and effective up to 300 meters. The results obtained corresponded exactly to those with the small-caliber rifle at a proportionately longer range. The effect of the pistol at 20 to 200 meters was the same as that of the rifle at 1000 to 2000 meters.

[1] *Beiträge zur klin. Chirurg.*, Bd. xix., H. 2.

MILITARY SANITARY ORGANIZATION.

In order to preserve the health of troops, treat the sick in camp and on the march, and to care for the wounded in battle, a well-trained and well-equipped corps of medical and sanitary experts becomes a necessary and important department in every army organization. Whatever care may be exercised in the selection of men for the military service, and however healthy they may be in time of peace and in garrison-life, on taking the field in an active campaign they are at once exposed, under the changed conditions, to various diseases of endemic or epidemic origin, which rapidly thin the ranks and fill the hospitals. Thus it becomes the task of the medical department not only to aid the wounded in action, but also to protect the troops against the outbreak of scurvy, diarrhea, dysentery, cholera, typhoid, typhus, and malarial fevers, which in past wars have been far more destructive to the efficiency of armies than are the weapons of the enemy. Medical officers must be prepared to give advice in all matters relating to the location of camps, water-supply, the construction, heating, lighting, and ventilation of buildings; the quality of food and clothing, the care and cleanliness of the men, and general police and sanitary regulations. They must provide material and trained assistants for treating the sick and disabled, hospitals to receive them, and transportation to relieve the army from encumbrance.

The efficiency of the medical department in these duties will depend very much upon the thoroughness of its preparation, organization, and administration. This important subject has been considered and discussed in all its minute details by military surgeons, especially since the introduction of improved firearms, with a view to reach some satisfactory solution of the many difficult problems which it presents. Elaborate plans have been proposed for carrying into effect the purposes of army medical aid, which work well on practice maneuvers and in sham battles, but which fail to meet the practical requirements of actual warfare. A military sanitary organization suitable to the conditions of peace and to all field operations when the enemy is at a distance is readily formed and easily managed. But the difficulty is to devise a system that will be sufficiently comprehensive for the needs of the sick and wounded on the field of war and in battle without encumbering the movement of active combatants.

In attempting to construct such an organization, it is necessary in the first place to have some knowledge of military grand tactics and the maneuvering of large bodies of troops in the face of the enemy. The best preparatory instruction on this point can be gained from the study of past campaigns and battles, both from a military and a medical aspect. The topographical features of battle-fields and regions of country where great battles were fought; the details of events and movements as two hostile armies approached; forced and night marches and preliminary engagements; victories and defeats; conditions of weather and roads and lines of communication; actual work done and aid rendered by the medical department at different stages, and on both sides; difficulties, hindrances, and failures, and their causes. These and many other facts in past experience will furnish

object-lessons of great value to any one who would undertake to organize and equip a military sanitary attachment of the best practical utility in future wars. He must endeavor to comprehend the real conditions which prevail during actual war, and adapt his scheme to meet the difficulties likely to be presented. Not until the element of *hostility* has been introduced will it be possible to form any clear conception of the situation, and prepare to do the best that can be done without inviting failure by attempting what is impracticable or impossible.

Military sanitary organizations in different armies are all based on the same principles. They are so constructed as to embrace four principal lines of medical aid. The first extends from the firing-lines to the nearest convenient sheltered places on the field, where the wounded come under the surgeons' care and receive preliminary attention; second, from that point to the ambulance or principal dressing-stations; third, from there to the field hospitals; and fourth, from the field to the general hospitals at the base of operations. Each of these is provided with its own personnel, material, and transport.

The **commissioned officers** constitute the medical corps, of whom there is a surgeon-general, a chief surgeon to each separate army corps, division, brigade, and hospital, and one or more surgeons with each regiment, battery, and separate detachment.

The **non-commissioned personnel** comprise the hospital corps —a body of hospital stewards, acting stewards, and privates—noncombatants selected for the duties of pharmacists, clerks, wardmasters, cooks, nurses, litter-bearers, ambulance-drivers, and orderlies. They are enlisted for this special purpose, and in time of peace perform their duties at the garrison hospitals and on the practice marches, where they receive from the medical officers a thorough training in all the practical and theoretical details of preparation, both for peace and for field service. On mobilization of the army they are distributed to the hospital and ambulance attachments and to the regiments—some for duty at the field hospitals and dressing-places; while others are formed into companies under medical officers, to man the litters and bring in the wounded.

Company Instruction.—In order to provide some means of prompt aid for the wounded during and immediately after an engagement, the combatants themselves receive instruction in the methods of handling injured persons and giving assistance in emergencies. When going into battle, one or more soldiers may be ordered by the company commander to help their comrades from the firing-line to a place of safety, if necessity should require it; and when the firing ceases, to assist in getting the wounded off the field. In the organization of foreign armies such soldiers are auxiliary to the sanitary attachment, and work with it as litter-bearers; but this anomalous status is inconvenient. Men should be either with the combatants or wholly detached from them.

Material for field service should be devised in time of peace, and especially prepared for its purpose. After carefully considering the details as to weight, bulk, necessity, suitability, and the conditions under which it is to be transported and used, samples or models of

each article—dressings, instruments, and appliances—should be adopted and made, so as to avoid delay when manufacture on a large scale becomes necessary. A considerable quantity of imperishable material should be provided and kept in store to supply troops in the early stages of any war that might unexpectedly arise.

On taking the field every officer and soldier is supplied with a "*first-dressing packet*," usually containing 2 sublimate absorbent gauze compresses, a 3-meter gauze bandage, and a safety-pin, all of which are sterilized and compressed before being wrapped and sealed in strong, light, waterproof paper. One recently adopted in the army of Austria-Hungary (Verbandpatrone) is compressed into the shape of a carton 7 by 3 by 2 cm. It is carried by the German infantry in the left trouser pocket; by the hussars and uhlans, sewed in the front of the cape; and by the other troops, in the rear pocket of the coat.[1]

In addition to a canteen, the hospital corps men carry a **hospital corps pouch** and an **orderly pouch** or knapsack. The former contains aromatic spirits of ammonia, 6 first-dressing packets, 1 meter of wire gauze for splints, 6 gauze bandages, rubber bandage, surgical plaster, pins, scissors, forceps, and knife. The orderly pouch is larger, and contains, in addition to the above, chloroform, antiseptic tablets, ligature, pocket-case, hypodermic syringe, and diagnosis tags.

Corresponding to these, the Germans have a " Lazarethgehilfentasche," with some medicines, 5 dressing-packets, 100 grams of absorbent cotton, 3 gauze bandages, 10 safety-pins, and 1 buckle-tourniquet; and a " Bandagentornister" with, among other things, 150 grams of chloroform, 100 grams of iodoform, 15 dressing-packets, 18 splints, 12 bandages, 1 kilogram of absorbent cotton, and 14 triangular handkerchiefs.

The **medicine-panniers,** which come next in order, are carried in the ambulances or on pack-animals, for use at the front and on the march. They should contain surgical material mainly, and very little medicine, which may be for the most part in tablet-form. The principal articles are splints and modern wound-dressings in large proportion, including some plaster rollers and rubber plaster for rapid fixation of splints; a light complete operating-set, which includes toothed forceps, tracheotomy-tube, razor, catheter, and non-absorbable ligature; tin trays, basins, and cups in nests; chloroform and inhaler; rubber tubing, needle and cannulæ, and pure sodic chlorid for transfusion; bichlorid, tricresol, iodoform, soda and green soap; rubber bandage and rubber gloves; hypodermic syringe and full set of tablets; purgative pills, quinin, and a few other medicines; concentrated food and stimulants; small case of "tools in the handle," and a lantern. The dressings consist mostly of bichlorid and iodoform gauze, absorbent cotton, and gauze bandages. They should be in small parcels, compressed and wrapped in strong waterproof paper, to save waste and contamination, and for convenience in transportation, handling, and distribution. The panniers may be so constructed as to form together an operating-table. The best material for the frame is probably cane wicker-work covered with rawhide.

The **medicine-wagon** is a multiple of the panniers, with a few additional articles, especially medicines. It comes up with the ambu-

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[1] *Deutsche Militär-sanitatswesen*, 1896, Murdecz.

lances for service at the principal dressing-station, and to replenish supplies farther to the front.

The **division field hospitals** in three sections—one for each brigade—have a capacity of from 50 to 200 beds ; usually supplemented by barns, houses, or other buildings that may be available. They are provided with bedsacks, to be filled with hay or straw ; field cooking and messing outfits, light folding furniture, including operating-tables ; food,

FIGS. 456, 457.—Private of the United States Hospital Corps, front and rear views (photograph from a figure in the Army Medical Museum).

stimulants, medicines, instruments, dressings, and all material and personnel required for the care of the sick and wounded. The stewards, cooks, nurses, and wardmasters belong to the hospital corps, and the surgeons to the medical staff, of whom the senior acts as chief, another as executive officer ; others attend in the wards, while those especially skilled in surgery are selected to do the operations. The permanently attached military sanitary organization with the active forces ends at the

field hospitals. The lines of communication from this point toward the base of operations and the general hospitals are under a separate command and have a personnel and material of their own, including trained female nurses.

Transportation of the wounded on the field is accomplished by means of light, strong hand-litters, pack-animals, ambulances, army wagons, and vehicles pressed into service from the country ; and on the
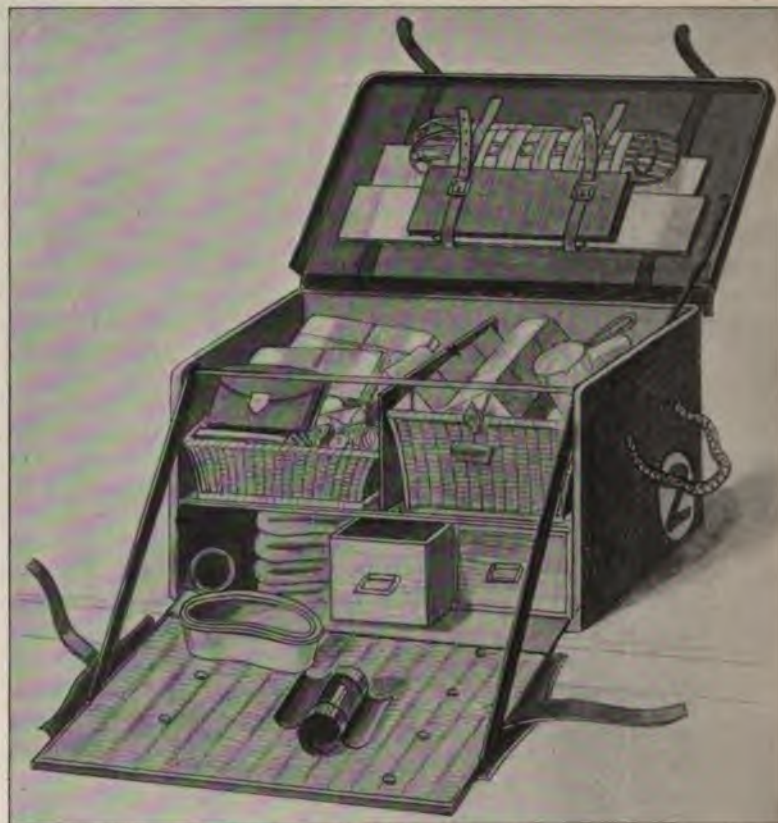
FIG. 458.—English surgical pannier ; cane wicker-work covered with rawhide.

lines toward the base, by ambulance wagons, railroad trains, and steam vessels fitted up as hospital transports.

SERVICE OF THE MEDICAL DEPARTMENT IN THE FIELD.

To every regiment of infantry and cavalry and battery of artillery are assigned one or more medical officers, a steward, and some men of the hospital corps which, together constitute the regimental sanitary personnel for duty in the field and on the first line of medical aid in action. They have at their service the individual dressing-packets, the surgeons' field cases, and the portable dressing-pouches. With each brigade, under the chief medical officer, is a third section of the division

hospital, including its proportion of hospital corps men, and material, ambulances, pack-mules, and panniers. With a division, under its chief surgeon, are the division hospital wagons, ambulance train, medicine wagon, and the ambulance company for duty at the hospitals and dressing-places and for handling the litters. In the corps organization there is usually in reserve one additional complete field hospital. When a regiment is detached, the pack-mules and panniers accompany it; and when a brigade is acting independently, its section of the hospital goes with it; but when the division operates as a whole, all the material and personnel are available.

The sick are attended in camp and on the march, and when unable to keep up, permits are granted them to fall out and join the ambulance train, where a medical officer will be found to receive them. Those requiring hospital treatment will be sent back or left at such places as the chief surgeon may direct. When the roads are bad the trains fall behind and are late coming into camp. Some break down, mules give out, and baggage may have to be abandoned or destroyed. When the marching is difficult from heat, dust, rain, or mud, the ambulances may be overcrowded, especially when there has been much fighting and the troops are exhausted from hard work and short rations, when there are many unseasoned recruits, and when sickness from malaria and diarrhea prevails.

Detachments pushed forward by forced marches to seize some point of vantage or for making a raid, a reconnoissance in force, or taking the enemy by surprise, leave their heavy material behind. Field batteries and perhaps a few ammunition and forage wagons may go; but the medical department will have only a few light ambulances or pack-animals for the occasion, which may take several days and incur considerable losses in killed and wounded. Cavalry raids often extend far into the enemy's territory without any wheeled transportation whatever. Duty with detached commands of this kind is very difficult.

When it is evident that a battle is about to be fought, the chief medical officers of corps and divisions endeavor to get early information as to the probable lines to be occupied by the troops, and the advantages and available resources of the situation for the care of the wounded. The location of hospitals, ambulance stations, and dressing-places will be determined by the physical and topographical features of the region. They will not be placed at a given number of meters behind each brigade and division, but must be formed at such favorable places as the ground affords. The first collecting- or dressing-place for the wounded is the nearest suitable point of protection from the firing-line. This may be close up to the front or far back, or to the right or left.

It is an invariable rule that the different collecting- and dressing-places, as well as the hospitals, should be grouped together at as few locations as practicable, in order to concentrate the material and personnel for mutual assistance and for the benefit of the wounded. The location that is most suitable for one field hospital will be suitable for several or all of them; and this will usually be at the nearest place to the wounded which combines safety with a reasonable amount of convenience, such as roads to and from the field, wholesome surroundings,

good water, fuel, etc. Those who expect to go upon the field and pitch their hospital tents in the rear of each brigade and division during a battle will be able to learn much from the study of past campaigns.

Measures for the care of the wounded in war are to be carried out under three principal conditions: 1. With stationary troops acting on the defensive in forts or field works. 2. With the forces which have to attack such fortified places. 3. With one mobile army operating against another in the open field. Under each of these conditions the result may be victory, defeat, or a drawn battle; or any temporary variation of the three.

In **defensive operations** there is time for preparation and the arrangement of material at convenient places. The wounded come under treatment earlier, with more advantages for management of such cases as fractures, chest and abdominal wounds, shock and hemorrhage, and for all operative procedures. Should the defence be unsuccessful, the wounded will, at least, be left together, and with more of their injuries dressed than might be under other circumstances.

In **attacking a stationary enemy** there will likewise be time for deliberation and for bringing up the wagons and ambulances, some certainty as to the disposition of lines and the position of field hospitals and dressing-places. Material for the care of the wounded will be available at all points, and the hospitals established ready to receive them. Artillery is largely used under such circumstances, both in attack and defence; and this will place many of the wounded at a distance from the enemy, where they can be easily reached and promptly removed. Assaulting parties that are repulsed, however, will leave many severely injured, who must wait until the enemy is either driven out or consents to their removal under a flag of truce. When counter-attacks or sorties from fortified positions are driven back, the severely wounded are also left for a time between contending lines.

When two armies operating in the open field come into conflict, greater difficulties are presented in rendering early and efficient aid to the wounded. The number of persons and the amount of material which it is practicable to bring upon the field during an engagement are limited by military necessity and the dangers and uncertainties of warfare. The object of first importance is success in battle; all else for the time becomes of secondary consideration. Whatever may have been the previous order of march in an army, on approaching a battle-field the wagon trains must fall out, the troops close up and move forward without encumbrance to their places. A corps of 30,000 men has 1092 wagons, not counting the artillery, and 5757 horses and mules, not including the cavalry or mounted personnel. The corps unit moves by one road, and on the march, with its minimum transport for five days' supply, it occupies a line 15 miles long.[1] The rear is thus one day's march from the head of the column.

When formation for battle becomes necessary the trains are sent back or parked under guard to protect them against a raid from the enemy. The 46 caissons with reserve artillery ammunition and the 70 small-arm ammunition wagons are essential, and some or all of them must be brought up within reach. The 150 ambulances are pushed

[1] *Organization and Tactics*, Wagner.

forward at different points, as near the scene of action as possible. Every road and bridge and avenue of approach to the field is occupied by troops moving into position and reserves coming up, and the enemy will spare no pains to cover, as far as possible, all these points with their guns. The difficulty of extricating the 62 heavy teams of the field hospitals from the interminable jumble of the general train, and getting them ahead over narrow country roads already crowded with infantry, cavalry, artillery, and ammunition trains, each claiming the exclusive right of way, will best be appreciated after a little experience. In bad weather and rough country the difficulty is increased.

Troops often come upon the field after a rapid march, and the wagons are far behind. Certain corps and divisions expected to take part in the battle are delayed in coming up, while others are detached to make concealed and hasty movements by the right or left, to strike the enemy in flank; hence roads must be cleared at all hazards to make way for them. Medical officers under these circumstances will be fortunate if they can get their field hospitals into position during the night or early the next day after a battle; but in the meantime the wounded at the front must not be left without some assistance.

The combatants on both sides press forward from various points, nearer and nearer together, and as they do so the number of casualties increases and the danger of approach becomes greater. Now here, now there, lines may be driven back with great loss, and the effort is renewed at another point in front or on the flank, as occasion offers or a favorable opening appears. Divisions and corps that have been severely handled are ordered back to the reserves and fresh columns sent in. Thus the wounded are widely scattered, left within the enemy's lines, or cut off for a time by exposed territory, over which they cannot be borne to the rear. Dressing-places established 1600 or 2000 meters behind the fighting-lines may serve to care for such injuries as occur among the reserves, and for the slightly wounded who make their way to the rear, but they will be too far away to aid those at the front until after hostilities cease. By that time the wounded will have accumulated in large numbers, perhaps, and it may be night, with rain and darkness, or the troops may have to fall back, and those unable to walk must lie on the field where they fell.

Under these circumstances some efficient means of reaching the wounded, collecting them, and attending to their immediate necessities soon after their injuries are received becomes a matter of great importance. In many instances it will be quite impossible to gather in all the wounded from advanced positions and places, where the hardest fighting occurs, until after the firing has ceased. Nevertheless, it is desirable that a greater effort and a larger force should be directed toward the establishment of collecting-places well to the front, in order to reach as many of them as practicable during the action. The surgeons—at least two to each regiment and one to a battery—should proceed with the command, instead of falling out at the "first zone of artillery fire," as in European armies, taking with them two combatants from each company. Those wounded during the advance should be taken care of by the hospital corps men who follow after, leaving the combatants where they belong, until the firing-line is reached. Only

the combatants themselves are near enough in the heat of the battle
to assist the injured to places of safety, where they can be attended or
taken farther to the rear.   All men of the company being instructed,
no selection for this service need be made until the occasion arises,
when as many are detailed as the exigency demands, and when this
duty is done they return to the command and resume their arms. The
hospital corps men attached to each regiment should also march up
with their command and bring hand-litters from the ambulances.

Collecting-places are selected, where the regimental surgeons
should be joined by others, so as to begin the work early and at the
front. Sufficient material for these places is not to be found in the
portable dressing-pouches, and often it cannot be brought up in
ambulances or carts, which encumber the field and form a target for
the enemy's fire.   **Pack-animals,** one or more for each brigade, with
panniers are quite practicable and useful in bringing supplies directly
where they are needed.

The surgeons can work to better advantage with a little protection
from flying missiles; but in some armies one surgeon to each regiment
must remain for moral effect with the men under fire. There is no
lack of bravery on the part of medical officers, but their unnecessary
exposure to injury on the field, where their services are so valuable
and their numbers usually so unequal to the requirements of the
wounded, is, to say the least, poor economy.

One or more soldiers, aided by the regimental hospital corps men
and, when practicable, by a medical officer, exert themselves to direct
and assist the wounded back to the collecting-places, designated by a
Geneva red-cross flag and the national colors.[1]   Surgeons and litter-
bearers from the ambulance companies come forward to assist at these
places, which should not be established at too many points.   More
than one to each brigade is not desirable. The object is *concentration*
for mutual assistance and to facilitate further removal in case of defeat.

With the personnel and material here provided much may be done
to get the wounded together out of danger; to protect their injuries
from infection by provisional dressing; to render some immediate aid
in shock, pain, hemorrhage, thirst, and exhaustion; to immobilize
broken bones and prepare the injured for transportation to hospital.
They are to be supplied with diagnosis-tags indicating the seat and
character of injury, the treatment rendered, and, when necessary, the
urgency of the case. As many as possible of the slight wounds
should be permanently dressed, to save time at places farther on and
avoid unnecessary changes. Those able to walk are directed toward
the ambulance stations, and others carried back to points where
wheeled transports can reach them.   Those who from shock or severe
injuries cannot be moved with safety will, at least, have their suffering
alleviated. It may be wise or even necessary to hold all the severely
wounded at this place until the battle is decided and the ambulances
can come up, or, in case of a retreat, where some provisions and
attendants may be left with them.   If the troops advance, new collect-
ing-places farther to the front may have to be formed.

Neither the soldiers themselves nor *untrained* assistants should

[1] Art. VII., Geneva Convention, 1864.

attempt to dress or touch the wounds, except to save life in severe hemorrhage—a possible but very rare contingency. For hemorrhage in the cavities of the body, where it is most frequent, they can do nothing, and bleeding from other parts is not dangerous, except when the main vessels of the lower extremities, from the bend of the knee to the groin, or in the upper extremities, from the elbow to the axilla, are injured. Life has been saved in such cases by prompt compression of the vessels with the fingers or a **tourniquet** improvised at the moment. All members of the medical and hospital corps should be provided with tourniquets; but the general distribution of these instruments insures their *indiscriminate application* and the infection of many wounds, while it also tends to foster a false and exaggerated idea— already too prevalent—of the danger of hemorrhage from gunshot wounds.

First-aid packets are of great service in the hands of trained attendants and surgeons who know best how to use them, but it will be safer to permit the wounds to wait rather than take the chances from unskilful dressing. With fire, and even a limited amount of water, the material in the panniers will enable surgeons to sterilize their hands, instruments, and the seat of injury, and apply dry aseptic dressings of plain, iodoform, or bichlorid gauze. In fractured limbs light splints of felt, thin wood, wire, straw, twigs, etc., may be secured by one encircling strip of adhesive plaster above and below, either alone, to save time and material, or with the addition of a single roller of gauze or plaster bandage. The German regulations direct that splints shall not be laid on outside the clothing.

Operative surgery at the first collecting-places will ordinarily be limited to the barest necessities. Needful and urgent minor operations may be performed, but no unnecessary surgery should be undertaken and none done without the strictest antiseptic precautions practicable. Conditions are usually unfavorable here for any formal surgical work. The main object is to get the wounded back to hospital as soon and as safely as possible. Simple flesh wounds will require only dry protective material, such as that in first-aid packets, which proved so valuable in the war in Cuba and the Philippines. Those more lacerated and liable to infection may be cleansed around the seat of injury, to remove dirt from the surface, without probing for foreign bodies or disturbing clots of blood which may occlude the openings. All unsterilized dressings should be boiled and wrung out before being applied, after which they will soon dry in favorable weather.

Hemorrhage is to be arrested (1) by compress and bandage, (2) by aseptic tampon, (3) by ligature to the ends of bleeding vessels in the wound, or, possibly, by tying the vessel in continuity. When such constriction of a limb is required it should be elevated, and the bandage—gauze or rubber—applied from the toes or fingers upward to prevent swelling. Bleeding wounds of the lung require drainage rather than any attempt at occlusion. The point of entrance may have to be enlarged to reach a splintered rib or an intercostal artery. Movements of the chest are to be limited by adhesive strips or bandage, and the patient kept quiet under simple protective dressings. In wounds of the skull, splinters of bone or depressed fracture may require the immediate use of a tre-

phine; and tracheotomy on the field has been found necessary in a few instances. Wounds of the abdominal viscera and pelvic organs are to be sent, when practicable, to hospital as quickly and quietly as possible, or, when impracticable, kept still where they are.

When large numbers of men are shot down within a brief period, as often happens in great battles, lack of time as well as of material and assistance is the insurmountable obstacle which prevents any very careful detailed attention to their injuries at the first-collecting places. Getting them together and hastening their removal to the rear then become the chief occupation of the surgeons and attendants.

Division ambulance stations will generally be established at some safe place farther back, in the vicinity of buildings or in ravines, along the banks of streams or behind elevated ridges, and convenient to lines of communication. Such suitable points may be many or few, near the front or far off, according to circumstances, the advantages of the ground, and the availability of roads, bridges, etc. These stations constitute the second line of medical aid, intermediate between the first collecting-places and the hospitals, where the wounded can receive more careful attention and remain, if necessary, until the latter are prepared to receive them. They are provided with tents, additional splints and dressings, operating-tables, light cooking-apparatus, hand-litters, ambulance companies of the hospital corps, and ambulance surgeons. Bearer detachments under medical officers advance to the first collecting-places or beyond and bring in the wounded, assisted, as far as possible, by the ambulances.

English regulations prescribe that the ambulance train shall be divided into two sections, one to ply between the dressing-places and the ambulance stations, and the other between the latter and the field hospitals. Ambulances may not reach the first dressing-places during an engagement, and when they do the wounded should not be unloaded and reloaded, but, if possible, taken direct to hospital. The sooner they get to some permanent place of rest after their injuries are received, and the less they are handled on the way, the better.

The location for field hospitals should be selected and made known as early as possible, so that the wounded can be sent to *that point* without waiting for the wagons. In furtherance of this important object, it is well to have an **advanced detachment of the hospital** in two or three light ambulances, provided with material for the surgeons and assistants, who can take station there and make a beginning in case of the usual delay in getting up the heavy trains.

When the wounded have to be held overnight or for some time at the ambulance stations, it becomes necessary, especially in hot weather, to make a thorough examination of severe injuries, to renew provisional dressings, remove constricting bandages, ligate vessels, apply drainage, and do such other operations as may be urgently needed to maintain asepsis and secure safety during further transportation. *Conservative surgery* on this part of the field should be a cardinal rule, and particularly with regard to amputations. Severe gunshot injuries of the long bones in soldiers treated under tents and open outbuildings often do well without any mutilating operation. Haga[1] reports that

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[1] *Loc. cit.*

on the field in the war with China he selected for amputation some gunshot fractures of the femur, but, being obliged to abandon the operation for lack of time, he was greatly surprised afterward to find that they had healed with good results. Amputations after the battles of Santiago and Manila were very rare.

Small, entirely detached pieces of broken bone may be removed, when necessary, by enlarging the wound of exit, after which all possible effort should be directed (1) to maintain asepsis, and (2) to prevent shaking up and displacement of the fragments during transportation. The chances of necrosis in other pieces of bone may be safely left for later consideration. Such cases require some place of rest within a reasonable time after injury, and some carefully adjusted immobilizing splint. If they are jolted about from one point to another for ten days or two weeks immediately after a battle, infection and secondary amputation may be the result.

Laparotomy at the ambulance stations will hardly be practicable, or even justifiable. The time, experience, skill, proper material, competent assistance, and other special conditions which this operation demands will rarely be available, and without these nothing but failure can be expected. Moreover, *such cases require complete rest after operation, which they cannot have on the field*.

At the field hospitals all the conveniences for modern surgery, except perhaps time, are provided, and any operation, including laparotomy for gunshot wounds, may there be done. A considerable number of penetrating abdominal wounds are received in battle, but, unfortunately, many of these patients perish from shock or hemorrhage before they get to the hospital, while others arrive too late for successful operative treatment. Cases of slight injury and men able to walk are usually among the first to come in. Nourishing food and refreshments are provided for the wounded as soon as they reach the hospital. The activity of the surgical staff is directed to a careful examination of all injuries, taking the most urgent cases first. Operating-boards are organized, and operations conducted with every possible aseptic precaution. No bulky or complicated sterilizing apparatus is necessary; boiling can be done in simple tin or copper vessels, which, to save room, fit into each other in nests of six or a dozen, and serve for the hands, instruments, and all other purposes. Towels, gauze pads, silkworm-gut, silk, horsehair, and everything used in an operation that will stand boiling, including the tin vessels in which pads, instruments, and ligature are placed, should be boiled. Sterile catgut and tendon ligature of reliable quality are now furnished dry and sealed in small paper envelopes, convenient for field use. Boiled horsehair is an excellent material for skin suture. For the hands there are hot water, green soap, alcohol, bichlorid and mustard, or potassium permanganate and oxalic acid, and also rubber gloves.

The region of wounds is to be thoroughly sterilized. The openings in some are enlarged to remove foreign bodies or for drainage, while others may be closed, and all permanently dressed. When the wounded have not remained too long on the field, all except the more lacerated injuries and those that have been handled may be regarded as aseptic. Fractures are readjusted and plaster or other proper splints

applied; but amputations are restricted to those cases in which, from injury to important blood-vessels or nerves, it is evident that the limb cannot be saved.

Wounds of the joints will often do remarkably well under aseptic treatment without any serious operation. Clots of blood and spiculæ of bone may be removed, the wound flushed with salt or boric solution, and treated with light drainage, fixation, and absorbent gauze-cotton dressing. Typical resections will very rarely be needed. In soft bone at ordinary ranges the new bullet makes nearly clean perforations.

The surgery at well-appointed field hospitals is based on the same principles as pursued by modern surgeons elsewhere, and need not be discussed at length. The wounded must be prepared as speedily as possible for transportation or transfer to other hands, in order that the surgeons and their assistants may be relieved and the tents and material repacked in readiness to move on with the troops. The time for this is sometimes very short, while at others there is no immediate hurry. A guard is needed to keep order and pick up stragglers and those able to return to their commands. Here the army is usually met by physicians, surgeons, and trained female nurses from civil life, and here near the field all the severely wounded and sick who would be injured by further movements should, if practicable, be kept, with ample provision for their treatment, until they are in a condition to bear transportation by ambulance, railroad train, or steam vessel to the general hospitals at the base of operations. The slightly injured and those only temporarily ill ought to be sent to hospitals not too far away, where they can be restored to their commands as soon as they recover. As wound-infection most frequently arises from contact with septic hands, the most stringent regulations should be enforced to guard against this, even though the wounds be left without dressing until they reach the hospital. The contact of clothing is less dangerous than that of septic fingers.

On the night after a battle and during the following day, when the forces have not been driven back, the labors of the medical department are often severe and incessant. After many of the great battles in modern wars some of the severely wounded have lain twenty-four hours or even longer on the field before they could be brought in. Large gasolin illuminators and electric lights have been devised and proposed to aid in the search for wounded at night; but the use of such apparatus would be possible only after the enemy had been driven well back out of sight. With the usual animus which prevails between combatants in war, even a lantern on the field, or a light at the window of a hospital, when visible, is sure to attract the enemy's fire.

Men killed on the field are often found by those who, from lack of personal acquaintance or from changes that have taken place after death, are unable to recognize the bodies. Long lines of white head-stones marked " unknown " are seen in our national cemeteries. Such distressing cases may be easily avoided by a regulation which requires every officer and soldier in the field to wear about the neck, beneath the clothing, a small metallic tag, on which his name and the date and place of birth are engraved. This humane provision should never be overlooked by military authorities in going to war.

CHAPTER XXXI.[1]

NAVAL SURGERY.

FEW of the occupations of mankind are so fraught with peril to life, and well-being in all its bearings, as that of mariners; and, generally speaking, their careers are spent in an environment at variance with hygiene. Their lives are isolated, as a rule, from our common humanity, and their surroundings usually aggravate any existing morbid tendency or effect; while absence and the constant restraint and monotony for long periods, broken only in the vast majority by periodical excess, also tend to shorten their days.

In their sleeping-quarters the breathing-space is about one-fifth the amount said to be requisite for human beings ashore; and this air is often hot, humid, and vitiated by the conditions and emanations of aggregate living. In active service the dietary is limited to a small number of substances artificially conserved, the daily fresh-water supply is often curtailed, the work is hard; and there is exposure to frequent variations and changes of climates, seasons, and weather, in addition to constant experience in foreign countries of unusual morbific influences. All these set the seaman apart as one claiming distinct consideration and treatment at the hands of our art.

Before the advent of the present era of steam, electricity, and other motive forces in navies, the character of the duties of the naval surgeon was entirely different from what it is at present. We do not now very often meet with such affections, injuries, and accidents as were common in former times. Masts and sails have gone forever; anchors, chains, and all heavy weights are moved by the power of steam or other machinery; the great guns and implements of offensive power train and move to the touch of the small wheel or lever. Nor do our patients present the chronic illnesses of the former days, when, with sail-powered ships and long voyages, there also reigned the old methods of surgery—the pre-aseptic days. Chronic ulcerations and deformities from genito-urinary and syphilitic diseases, unhealed fractures of bones, parasitism, and the hopeless cases of obscure internal disease are now rarely encountered. The progress of knowledge has banished these specters from the sailor's life.

Yet, with all that can be said, our art is still applied with difficulty on shipboard; the circumstances oppose success in many instances, and these are in great degree unavoidable and inseparable from the conditions of the compressed human and material activities of the modern fighting-ship. The fact that the life of the sailor is materially improved in diet, contentment, and comparative freedom from long deprivations is the chief gain, and, as a rule, presents us with better material in our patients than was formerly the case.

With the extraordinary changes in ships there has also occurred a

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[1] The editors deeply regret to be obliged to announce the death of the author of this chapter at the moment of going to press.

great change in the character of the injuries and in their relative frequency. Formerly, the greater number of traumatisms were due to the manipulations of the sails and ropes (" man-power "), the guns were small and easily handled, deck-space was ample and free from obstructions, and the crew in great part spent the time occupied in the open air. At present, during peace, the accidents are due mainly to the tending and handling of the very numerous engines and machinery (a battle-ship containing nearly a hundred distinct steam cylinders), to the complicated decks, steep metal ladders, narrow hatches and passage-ways; to burnings, slight explosions, contusions, lacerations; and with a few cases of submersion, heat-stroke, and asphyxia.

The relative frequency of surgical diseases and injuries in the largest navy extant, that of Great Britain, is as follows:

English Navy.—Surgical diseases, average number per 1000 of strength for six years (1887–1892):

	No. of Cases.	Daily Sick.	Invalided.	Deaths.
Septic diseases	0.88	0.06	1.02	0.05
Syphilis, primary	57.16	5.01		
" secondary	23.97	2.48	1.97	0.05
Gonorrhea	76.21	5.09	0.69	0.02
Genito-urinary diseases	9.80	0.56	0.82	0.19
Eye and ear diseases	5.18	0.50	1.44	
Poisoning	0.85	0.02	0.02	0.04
General wounds and injuries .	3.87	0.06	0.16	1.83
Local wounds	197.51	6.57	1.92	0.28

English Navy, 1893.—

Average number daily sick-rate per 1000 of strength 41.32
Invalided 27.04
Deaths[1] 11.29
Death-rate from disease 4.07
" " accident and injury 7.22
Average death-rate per 1000 for twenty years, from violence 33.85

German Navy, 1893–1895.—

Average strength at sea, 10,886; on shore, 9172. Total, 20,058. Constantly sick, 36.1 per 1000. Average duration of sickness, 13.6 days. Of the total deaths, 48 per cent. were due to accident; 6 per cent. to suicide.

10 deaths due to powder explosion (" Baden ").
94 " " boiler " (" Brandenberg," 25 killed).
40 " " drowning.
6 " " falls from rigging.

*U. S. Navy, 1896.—*Average strength, 13,768.

Admissions for disease, 8652 ; ratio per 1000, 628.42.
" " injury, 2056; " " " 149.33.
Deaths from disease, 64 ; per 1000, 4.51.
" " injury, 14; " " 0.98.
Ratio of deaths from all causes per 1000, 5.49.
" " " " " " " " for 1895, 6.82.

Table of Surgical Diseases and Injuries, U. S. Navy, 1896.—

Diseases of bones and contiguous structures 38	Motor apparatus 439
Synovitis, thecitis 62	Venereal and genito-urinary diseases . 1244
Abscesses 287	New growths and cysts 22
Carbuncle 21	Wounds and injuries 1807
Cellulitis 31	Extraneous bodies 9
Skin diseases 778	Poisoning 246
Parasitic diseases 30	Invalided and unfit for service 58
Visual apparatus 151	Deaths 42

[1] This high rate is due to the sinking of the " Victoria," with loss by drowning of 358.

U. S. Navy, 1896. Character of Injuries.—

Abrasions	44	Sprains	410
Burns	95	Contused wounds	194
Asphyxia	3	Incised "	125
Submersion	10	Lacerated "	200
Contusions	449	Punctured "	54
Concussions	51	Gunshot "	8
Deformities	2	Other surgical injuries	23
Fractures	137	Wholly disabled	28
Luxations	24	Deaths	11
Hernia	48		

Ratio of wholly disabled per 1000 of cases, 0.185.
Ratio of deaths per 1000, 0.072.

In 1889 (English Navy), of an effective strength of 50,790 officers and men, there were 10,697 general traumatisms (210.61 per 1000). Of this number, 147 were heat-strokes, with 7 deaths ; 53 cases of submersion, with 33 deaths ; and 19 with multiple injuries, 10 of which terminated fatally. Local injuries comprised 730 burns and skin-lesions, while fractures and luxations were the cause of 21 deaths.

In 1890, of an effective strength of 53,350 men, there were 10,805 cases of traumatism (202.53 per 1000). General accidents comprised 25 heat-strokes, 6 general burns with 4 deaths, 235 cases of submersion, and 17 cases of general accidents with 14 deaths. Seven hundred and twelve were local burns, and fractures and dislocations caused 21 deaths.

These figures indicate that surgical cases are much less formidable than medical cases, and approximate the proportions observed for the army.

Taking the attainable figures for the three years, 1894–1896, we have a proportion of 6.52 per 1000 of effective strength, of which traumatisms alone give not over 2.86 per 1000.

Diseases and injuries among seamen are closely connected with their duties. Thus, men much employed below decks are anemic and debilitated. Lookout-men suffer from weak sight and loss of visual accommodation. Helmsmen are liable to accidents at the wheel and suffer from exposure. Men much aloft suffer from traumatic lesions of the hands and feet, along with a tendency to cardiac hypertrophy and hernia. Engine- and fire-room men, working under conditions of high temperature and vitiated air, are subject to heat disorder, vertigo, and convulsions ; while burns and lacerated injuries are very frequent.

THE COMMONER SURGICAL INJURIES.

Simple Wounds by Cutting-instruments.—As one of their most cherished possessions allowed by regulations, seamen carry a large clasp-knife. At the present day the end of the blade is blunt, but the blade itself is large and heavy. The men use the knife for many and all purposes, from paint- and spar-scraping to table-use and tobacco-cutting, and it not infrequently comes into use during their many quarrels. Usually the wounds made by this knife are of the fingers and hands, or of the large muscles of the thighs, deeply dividing tissues and involving dangerous bleedings. Struggling to seize another's knife has frequently resulted in transverse cuts of palm or fingers. Slicings of the fingers from the cook's knives or from the long, slender bread-knife are also much in evidence. These incised wounds, as a rule, do well with simple management, taking care that the wound is well cleansed before applying the dressings. Deep suppurations do, however, follow, and their treatment is the same as of similar wounds in civil life.

Punctured Wounds.—The vast majority of these are also of

minor importance. Marlin-spike wounds are less and less seen with the disappearance of sails from ships. The custom of going barefooted upon all possible occasions causes sailors many punctured wounds of the feet; but, excepting when produced by poisonous substances, or the spines of fishes and sea organisms on tide-washed shores, splinters, and so on, they require only protective dressings. Sea water irritates and aggravates all wounds, and it not unfrequently happens that simple wounds are complicated with more or less dermatitis of the region involved. Stab wounds may be expected at any time, and chiefly in countries where the populations are prone to use the knife. In such seaports the men in their shore-goings are at times set upon in their quarrellings by the natives, sometimes with painful results.

Wounds of the hands and feet are the most common among seamen, and probably as many as 3 per cent. of the men on an actively employed modern war-ship will require treatment constantly for these annoying cases. Splinters of wood and metal, pieces of coal, or some one of the innumerable details of the machinery in motion are responsible for most of them.

Injuries and wounds of the head and trunk are thought to be less frequent than formerly, due to the passing of masts and sails. Fearful accidents and severe injuries of the head, concussions, fractures, and lacerations, in former times resulted from the not rare falls from aloft, and interesting accounts are given by the older writers of their frequency and seriousness. In falls from aloft the hands and arms may be lacerated with friction-burns, made in the efforts to grasp parts of the rigging. These wounds require the most painstaking care for any adequate success, the tissues being in "strings" and much devitalized. Hands and feet caught in blocks and sheaves may be pressed out of all shape; but, as a rule, do fairly well under treatment. The sudden tightening of slack cable or line, followed by bruising injuries of the feet or ankles, is to be expected.

In the order of frequency, **fractures** come next after contusions and bruised wounds. These result from the insecure footing, due to movement of the ship, and the weight and complexity of the materials, machinery, and great ordnance in the present vessels. These being not unlike fractures generally, need no further remark here. The surgeon's outfit includes varieties of splints and materials sufficient for the usual management of these cases; and, as a rule, the earliest possible immobility and ambulant treatment is advisable. A large spacious swinging-cot is employed for these cases, and the surgeon's ingenuity is tested severely in managing them successfully at sea.

Those men, skilled seamen as a rule, whose duties pertain to the heavy anchors and chains, with the attendant steam machinery, are in constant peril of injury during the time of their actual work of anchoring the ship, or when securing the anchor, and some of the most serious injuries occur among them. Enormous weights are then suspended in mid-air, the men tending and guiding numerous lines and heavy sheaves, with possibly a moving base. In "letting go," the anchor gear is liable to sudden checks and breaks, while the great cables seem animated with a vicious force in rushing overboard. In "heaving in," the chain strains and stretches around the drum, and the task

of safely handling and securing the unwieldy, heavy mass is not without its dangers at all times. Serious accidents, crushing injuries, and compound fractures are not uncommon, while the outcome is more often unsatisfactory than otherwise, notwithstanding the greatest care.

The Engineer's Force.—Owing to the necessarily contracted spaces in which the machinery, boilers, and fire-rooms of naval vessels are placed, accidents and severe injuries may be looked for more frequently among these men below than from any other class on shipboard. The vital machinery and accessories on war-ships are all below the water-line and covered by an armored deck, unlike the steamer in the merchant service, where the vertical space employed allows at once of more desirable room, with increased light and more economical disposal of power. There is limited room in attending the enormous amount of detailed mechanism literally on all sides, greasy metal foot-plates, uncertain to the hurried foot, and the ship's motion requiring constant hold and support in moving about; all these add an element of unsafety to these men's lives. Long and frequent hours of work or "watches," under great heats and a vitiated atmosphere, the common experience, exhaust their energies; and from all the conditions it is readily seen how great is the liability to injury. Unfortunately, these accidents are often so severe that amputation and "trimming" operations are required. More serious strokes and fatal crushings of the trunk happen only at long intervals. Hands and arms suffer most, and the writer has seen the forearm cut off at the wrist by one downward movement of the yoke in the eccentric. Shock is severe in these engine-room injuries, some hours usually being required before repair operations may be attempted. Notwithstanding the greasy, blackened appearance, these wounds and lacerations heal kindly enough. When combined with burns or scalds, repair and restoration are long delayed. Because a finger or part of a hand has been compressed to a bluish-white, waxy mass, it should not be taken as proof of its complete loss; and it is astonishing what success may be attained with most of these cases. Hence there should never be any haste in operating and removing apparently destroyed terminal portions of members, for the recognized principles of restorative care and conservative surgery may be rewarded with gratifying success.

Service in the torpedo-boats may be said to be an exaggeration of the engine- and fire-room service of the larger naval vessels, because of the still greater complexity, compactness, and delicacy of all parts in these rapid craft. Added to this is the fact of nearly certain destruction once an enemy's rapid-fire zone is entered with discovery. Accidents from the compressed-air mechanism and cylinders (torpedoes being automobile from this source) are also to be noted, these being of the nature of explosions.[1] The battle casualties of torpedo-boats are beyond all the usual proportions, the killed and wounded coming within a ship's fire zone ranging from 50 per cent., in a few minutes of a partial action (United States Torpedo-boat "Winslow," Cienfuegos, Cuba, May, 1898), to complete destruction and sinking (Japanese boats, Port Arthur, China, in 1894; and Spanish boat attacking United

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[1] Several such are reported in the *Arch. de Méd. navale*, tome lii., 1889.

States Flag-ship "Olympia," battle of Manila Bay, May 1, 1898). These craft, upon their appearance and discovery, their usual fate thus far, become the chief target from the opposing ship or ships, and, being unprotected by armor, speedily succumb under the withering fire of the machine- and rapid-fire guns, long before they reach their effective range (600 yards). There is also little protection from the ordinary perturbations of sea and weather.

Explosions of Ordnance.—Since the muzzle-loading gun has disappeared from the batteries of the modern naval vessel, and this type of ordnance has become quite obsolete in the strict technical sense, accidents from premature explosions are rarely met with, and we are spared the periodical occurrence of the painful scenes depicted by former writers. It is not so long ago, however, that one heard of the arms of the rammers and spongers being torn away and flung in the sea, and, at every occasion for saluting, grim custom has required the presence on board of the surgeon. Nor are explosions of naval ordnance, due to defects of manufacture or to excessive charges, so common as formerly.

Such great explosions as, for instance, occurred in the Russian ironclad's turret in May, 1897 ("Sissoi-Veliky," the breech-block of a 12-inch gun blew out, the escaping gas filled the turret, causing it also to explode), are due to imperfect closing and locking of breech-block mechanisms ; and one hears of narrow escapes not infrequently from this cause in all services. In the instance of the Russian ship cited, the wrecking and destruction were inconceivably wide-reaching ; but few, if any, men escaped (20 to 30 were killed and wounded), and the ship's section occupied by the turret was in great part destroyed.

Gun construction is now almost an exact science, requiring careful, painstaking steps, from the selection of the ores and metals to the final conclusion of the firing-rounds on the testing- and proving-grounds. No gun is mounted on shipboard without its safe transit through all the manifold consecutive trial stages.

Some of the great losses from explosions of guns of large caliber are as follows : French ship "Suffern," at Toulon (1858), 39 men killed and wounded ; English ship "Thunderer" (1879), 42 men killed and wounded ; English ship "Collingwood," where a charge of 714 pounds of powder exploded a large gun, killing and wounding over 20.

That we may expect more great gun explosions in the future is likely enough, considering that the question of the "life" of these large pieces of ordnance is still an undetermined quantity. After a hundred rounds have been fired from many of the guns now mounted on most naval vessels in existence, of a caliber at and above 10 inches, they are not safe. The later and better guns, however, are withstanding 200 rounds and over safely. The noted 100-ton guns of the Italian and English navies were discarded after their seventieth round, and are now obsolete. The prevailing large guns of first-class battle-ships are of 13-inch bore, weigh not over 62 tons, and their safety-limit has not yet been reached at 150 rounds. Small-bore guns in the better makes do not seem to have any limits to their firing-safety and designed strength; though here, too, explosions have occurred. Fixed ammunition and charges of explosives have also added an element of greater safety.

Magazine explosions are of rare occurrence, because of the extra-ordinary precautions and safeguards generally practised. Some of the most destructive on record remain unexplained in their causes. But

the unexpected combustions and explosions of the deteriorating and changing chemical elements of the several explosive compounds, stored in various parts of the vessel, are in some degree traceable, though the subject cannot be entered upon here.

Boiler and Steam Explosions.—Boiler explosions are becoming rarer with the universal use of the tubular type of construction. Though steam pressures are extraordinarily high, there are many safeguards, and the skilled men in control note the danger-indications in season. Escaping steam is, however, a never-ceasing peril in the modern high-powered ships, and burning and scalding accidents are unhappily common.

Boiler explosions and catastrophies, such as—English ship "Thunderer," July, 1876, 15 sudden deaths, and 59 scalded, of whom 30 also died; French ship "Revanche," 1877, with over 100 casualties; and the "Dupuy de Lome," French, 1879, a score of men scalded in an atmosphere under high pressure, forced draught—seem to have ceased. In these instances the body, horribly disfigured, was generally wholly enveloped in olive oil before transport to the hospital. Zinc oxid and lime water were mixed with the oil in some cases. Opiates were required to still the cries of the sufferers.

Escaping steam from a fractured pipe is an ever-present possibility, with, as a rule, only partial scaldings, where a large volume has suddenly overcome a section of men in a compartment before being checked. Heroic courage is required to act intelligently and promptly to check these leaks, with resulting burned hands and arms. These scald-burns are long in healing, and great difficulty is experienced in obviating the cicatricial deformities resulting, skin-grafting having to be practised. Steam inhalations and lesions of the mouth and air-passages are concomitant features of more serious import. First appearances of men scalded under these conditions are often deceptive, and the prognosis must be guarded. Following the first forty-eight hours, the usual period of greatest immediate danger to life, there are likely to supervene serious organic lesions previously unsuspected. Enfeebled organs promptly fail under the sudden strain of shock and the absorbed toxins. Alcoholics—and unfortunately these are numerous in the naval service—do badly under any method of treatment when burned or scalded. The great difficulty in cases of burns on shipboard is in handling them, owing to the lack of room and facilities, and they must be transferred as soon as possible to shore hospitals before the first dressing is renewed. The warm bath, the wheeled tub being brought to the bedside, and the patient gently laid on the frame and gradually lowered into the water, offers the best method to remove dressings and soak away discharges. At each renewal of dressings the same method is to be employed, and careful absolute cleanliness must be sought. Sterile gauzes, abundant cotton, and careful bandaging are essential. Other dressings are: bismuth, zinc oxid, europhen, orthoform, zeroform; and the newer similar antiseptic soothing compounds have their uses, either alone or combined with lanolin and white vaselin. (See Vol. I., Chapter V., for treatment of these injuries.)

The old mixture of linseed or olive oil with lime water continues in general use, either alone or thickened to a paste with zinc oxid, magnesia, bismuth, acetanilid, or similar substances. The prevention of sepsis is the great difficulty; while the care and patient labor involved in dressing these cases are extremely trying. The use of

artificial serum subcutaneously or by the veins offers a promising field in cases of toxic absorptions, lowered vitality, and shock; and hot saline rectal injections (110°–120° F.) have proved useful. Gradual fall of temperature, suppression of urine, and imminence of death follow these cases of severe burns, and may be met by the use of strychnin, warmth, and the usual supporting measures. Alcoholic stimulants must be used with caution. A large proportion of these engine- and fire-room burns are of such severe character and extent that the relief of pain is the chief indication, whatever the end may be.

Poisoned Wounds.—These continue to be met with on the coasts of tropical Africa, India, and in the south seas, and result from poisoned war implements, still in use among many aboriginal peoples.[1] Aside from the character of the wounds inflicted, the measures must almost invariably be directed to antagonize the toxic action upon the heart. Snake-venom, plant-extracts from various species in the different countries, and the rotting carcass of an animal or its blood alone, are the usual substances in which the weapons are dipped or smeared. Much of this subject remains so obscure that a list of plants is not here given, nor the methods said to be in use. But in Oceanica and the East Indies the plants are cardiac depressants; in the New Hebrides and some of the South Sea Islands the poison is like strychnin in its effects; in Africa, west coast, various poisons are used, including those of anthrax; in the tropical waterways of the Amazon and Orinoco, curare and similar plant-extracts. Le Dantec,[2] in New Caledonia, cultivated from poisoned weapons the tetanus-bacillus and a "vibrion septique." These poisoned wounds inspire such terror in the hapless victims that a great part of the nerve-phenomena is probably due to this feature.

The **treatment** consists in primarily allaying the patient's fears, opening up the wound freely, cleansing and clearing the tissues of all possible foreign substances. Free bleeding, suction by mouth or cupping-glass, the application of ligatures to delay absorption, and the internal use of alcoholic stimulation and cardiac remedies are to be tried. Injections of potassium permanganate solution deeply in the tissues surrounding the seat of the wound, combined with the use of ligatures constricting the parts, are of prime importance. After a period of ten to fifteen minutes, it is useless to try to destroy by caustics venom-toxins or bacteria deeply placed in the tissues. Nitric acid is superior to all others, however, if such are to be used. Sloughing and devitalization of tissues retard healing of these wounds, and possibly some of the later effects are consequent upon the extreme vigor and destructive effects of the local treatment usually pursued.

Hernia.—In the past five years in the U. S. Navy there has been an average of only 5 cases per 1000 of strength, owing to thoroughness of the physical examinations of recruits.

From various causes, nature of work, and minimum amount of marching, hernias in naval services are less frequent than in land forces.

In the U. S. Army, of 79 operations for radical cure, only 2 failures

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[1] Those interested in the subject may consult Lagneau's book, Paris, 1897; Bottard, *Les Poisson Venimeux;* and Cazeau, 1888.   [2] *Arch. de Méd. navale,* Jan., 1893.

are reported (for two years). By a recently established system many useful careers are continued in service, and the government is saved considerable expense in pensions. The subject of obligatory operation is being very generally agitated, justified by the recent developments and progress in the successful methods practised. But few operations for radical cure have been performed in the U. S. Navy; and, as a rule, the subjects reject them, preferring to leave the service with pension, under existing laws.

Appendicitis.—For 1895 the number of cases in the U. S. Navy was 10; in 1896 20, without any deaths so far as known. Details are lacking from which any instructive analysis may be made. There were 6 operations in the 20 cases (1896), performed somewhat late in the disease, followed by secondary operations for suppurative conditions. The conditions on shipboard—overcrowding and lack of proper facilities—naturally favor ultra-conservative methods of treatment with many surgeons; yet the change of sentiment impelling prompt surgical interference in these cases is rapidly becoming apparent, and is in accordance with the best surgical teaching and experience.

The History of Naval Casualties.—*Probable Losses and Casualties in Battle.*—Military writers estimate the number of deaths to the wounded on the battle-field as 1 to 4, and the total losses as averaging 12 per centum of the effective force engaged. The proportionate losses in the various arms of the army are stated to be (Heuyer)—

From the fire of small arms, infantry, 80 per cent.
From the fire of artillery, 18 per cent.
Other arms—swords, bayonets, etc.—2 per cent.
These figures reversed would make the losses for sea battles:
From the fire of artillery and its effects, 80–90 per cent.
From the fire of small arms, 10–20 per cent.
From other arms, nil.

Sea fights in modern times are entirely dependent on the fire and destructive effect of heavy ordnance, and small arms cut no decisive figure. Each shell exploding is immediately transformed into a multitude of missiles of greater or less size and weight, and, as a rule, forms a zone of positive destructive energy and effects that only armor of some inches in thickness can withstand. Special armor-piercing shells are even more destructive.

In future naval conflicts, ships being evenly matched, for instance, the personnel will not be considered as having suffered excessively if one-third are killed and wounded, though the severer sea duels of which we have good data show much greater losses.

The present naval vessel, with its curved protective deck of steel, averaging 3 inches in thickness, extending from side to side the whole length of the structure just below the water-line, divides the ship's company into those operating the offensive mechanism—guns, torpedoes, etc.—and who are exposed to the direct enemy's fire, and those below, responsible for the ammunition-supply, and the steam and other motor agencies upon which the very life of the ship depends, and who are exposed to the dangers of explosions, steam, torpedo destruction, and helpless sinking resulting from any accident whatever. So that no distinction into combatants and non-combatants in a fighting ship can be made, whatever their position or place may be in battle.

A vessel may bear the brunt of heavy gun fire for a few moments and receive appalling punishment, others in the same fleet may suffer but little; hence, casualties vary most unexpectedly in the same general

engagement. It must be admitted that accurate data concerning naval casualties, past and present, are very much lacking, and hence definite conclusions can hardly be formed.

Since the time of the appearance of the ironclad fighting ship there have been relatively few sea engagements of importance.

The following list for the recent past will show the varying fortunes. At Heligoland, in 1864, 2 Austrian frigates, 80 guns and 850 men, engaged 3 Danish frigates, 102 guns and 1728 men, with 36 killed and 108 wounded; the Danes losing 14 killed and 54 wounded. One of the Austrian ships had 31 killed and 81 wounded (22 per cent. of her effective strength). In June, 1864, the naval duel between the U. S. S. "Kearsarge" and the Confederate States ship "Alabama" took place. They were evenly matched, the former with 7 guns and 160 men; the latter, 120 men and a very excellent battery. The "Alabama" suffered a loss of 9 killed and 21 wounded (25 per cent. of her effective force), when she sank. The wounded on the "Kearsarge" numbered less than 9. At the great battle of Riachuelo, in South America, in 1865, a Brazilian fleet of 9 vessels and 1000 men successfully engaged a Paraguayan force of 14 vessels and 2000 men, assisted by shore batteries. The Brazilians lost 90 killed and 120 wounded, their total losses being one-fifth of their force, one ship losing half her company in killed, wounded, and drowned. It was estimated at the time that the Paraguayans lost 50 per cent. of their force afloat. At Lissa, 1866, the Austrians had 7 ironclads, 20 wooden ships, and 8896 men, opposed to 12 ironclads and 1076 men of the Italians (22 wooden ships not taking part). The Austrians lost 11 per cent. in wounded; Italians' loss, 12.7 per cent. During the naval battles in the Peru-Chilian War, 1879–1880, the casualties were greater, better and larger ordnance being then in use, and the battles were fiercely contested. One Chilian ship, the "Esmeralda" (sank with colors flying), after four hours' fighting against the Peruvian "Huascar," lost 40 per cent. killed and 40 per cent. wounded—80 per cent. of losses. In the same war, at the combat at Punta Angamos, lasting one and a half hours, between the ironclads "Huascar" (Peruvian) and the Chilian "Blanco Encalada" and "Cochrane," the former lost of her crew of 200, 100 killed and 50 wounded. The surgeon at work with a collection of wounded was killed, as were also most of the officers. The ship after the battle was a shambles, her armor not being sufficiently thick to prevent entrance of the enemy's shells. Later the "Huascar," now become Chilian, had 12.5 per cent. of her effective strength placed hors du combat. These battles represent feebly the probable casualties of a naval conflict between modern well-equipped ships or fleets with well-trained gunners. A single well-placed explosive shell of large caliber is capable of enormous havoc and destruction. As far back as Sebastopol, a shell exploding on the deck of one of the attacking ships killed and wounded 18 persons. At Lissa, one shot killed and wounded 20. A shell from the "Kearsarge," falling in the midst of 19 men on the "Alabama," killed and wounded 15 of them. In the Peruvian war with Chile, the "Esmeralda," by one shell, lost 4 officers and a group of wounded, including the surgeon; the "Huascar" had her turret cleared by one shell entering the gun-port, and by another lost 14 men. A French shell of only 10 cm. caliber, at Menan, Siam, killed and wounded 22 on a Siamese vessel. Shells of 34 cm. caliber are common in all navies, charged with melinite, cordite, and modern explosive of extraordinary power far in excess of gunpowder, and produce a terrible destructive area of several hundred yards.

At the battle of the Yalu, in 1895, one large shell killed and wounded 102 men in the Japanese ship "Matsushima." The Chinese ship "Quang Yih," off Corea, a few days previously, lost 66 per cent. of her company killed and wounded; and another smaller ship went down in the midst of the slaughter. The Chinese battle-ship "Chen Yuen" was stated to have lost 76 per cent. of her personnel. These data were furnished the writer by Commander McGiffen, an American, second in command of the "Chen Yuen." The commanding officer, surgeon, and a large group of wounded were destroyed by a shell on the Japanese cruiser "Hugei."

At the battle of Manila, May, 1898, on the Spanish fleet destroyed by the Americans, the casualties were from 40 per cent. to 70 per cent. of the crews of the Spanish ships.

The casualties depend upon several factors, skilful gunnery being the deciding element. The seven Americans who ran in and sank a coal ship in the harbor entrance of Santiago, Cuba, in June, 1898, all escaped with their lives, passing through a fearful cannonading.

The French maneuvers of 1897 demonstrated that four battle-ships were over an hour sinking an old steamer, at ranges within 1700 yards. For one successful hit, hundreds fly wide.

Glancing back to the great Nelson's time, the French ship "Redoubtable," at Trafalgar, out of 640 men, had 300 killed and 222 wounded. All the midshipmen were killed and all the officers wounded—81 per cent. of her company. Three other French ships suffered a loss of 50 per cent.

On the whole, single naval combats differ little from fleet engagements, and a probable casualty of from 30 per cent. to 50 per cent. of the personnel must be looked for. The "Huascar's" battles give us the most instructive data regarding these probabilities.

There occur in all naval conflicts pauses, due to the maneuvering for position and strategical advantage, in which periods of time the surgeons may hope to remove and relieve to some extent the wounded, performing the necessary operations that cannot be deferred, and clearing the gun positions of disabled men, and, if possible, carrying them to a position of safety.

It is estimated that so much time will be consumed by the bearers in transporting a single man to the surgeon's station, that such transfer will become impossible when the casualties go beyond 5 per cent. of the effective force, inasmuch as from five to ten minutes will be consumed on the average for each transfer. As naval battles are not expected to be prolonged over an hour, the wounded must in all probability remain near the place they fall, and be attended there by first-aid methods. Grouping of the wounded must not be practised, even if space offers, unless protected by heavy armor. Mattresses and hammocks plentifully strewn about in convenient localities may receive the wounded as they fall, and are of use in care and transport. Following engagements, transfer to hospital ships becomes imperative; or, failing these, the fighting ship must perforce give up much of her space and her offensive power for hospital purposes, depending on the number of casualties. Portable surgical tables and all the paraphernalia necessary, dressing, and supplies must be taken to the localities and temporary resting-place of the wounded for such operations as are required, and the ship must finally strive to reach the nearest hospital facilities on shore.

In the lists of injuries reported in modern battles, those among the actual gunners are of importance, and are due to the concussions and shocks of the gun discharges and violent changes in the density of the air within the confined spaces. The very large guns within turrets very rarely cause annoyance, the muzzle being well without the structure. Other guns not so placed, with the men not so protected from the muzzle discharge, are the source of much ear-disorder, some curious transient mental disturbances, and a great amount of pain. The presence of irrespirable gases is also an evil.

At the battle of the Yalu, in the details of the Japanese casualties, in number about 300, we read of: 148 fractures, 65 deaths; 76 burns, 2 deaths; 79 contusions; 67 penetrating and perforating wounds, 23 deaths; and 19 ruptured tympanic membranes. The cases of lesser injuries, of which there were many, and the peculiar mental phenomena of transient character, were not reported. Hearing in the latter cases was impaired, the men seemed hysterical and ran about aimlessly for some time, sober sense returning gradually. Further study of these mental states following prolonged concussion-effects would be interesting. Similar annoying effects are known to have occurred during the intense firing of the French ironclads in the maneuvers of 1897.

The nature of many of the wounds observed in recent naval battles indicates that, along with much mutilation and laceration of tissues, there are burning and charring of wide extent. The dead and wounded found by the American surgeons after the Manila and Santiago battles were frightfully mutilated; parts of the bodies were torn away, bones protruded through burned tissues, and portions of mus-

cular masses were chipped out clean by shell-fragments. One man, in a group of dead at Cavité, battle of Manila, had the whole abdominal wall torn away, leaving the exposed organs nearly intact.

It is evident that naval warfare wounds are to be, as a rule, quite different from those incurred in battles ashore; and that they are largely the result of the fire of heavy ordnance (rarely small arms), and from explosive shells of from 4- to 12-inch caliber: mainly, however, from the lighter calibers, 4- to 6-inch guns, of the rapid-fire type. These guns have great penetrating power and accuracy, with shells charged with modern high-power explosives; and even a small proportion reaching confined spaces and compartments, each, upon exploding, forms a destructive area of variable extent of white fusing flame, with a multitude of irregular metal fragments. So that the surgeon will have apparently quite as much of burned tissues with which to deal as with penetrating, perforating, or lacerated wounds. On land the small rifle bullet perforates without much killing, the wound healing rapidly; in naval battles, on the contrary, the wounds are more serious and from a variety of missiles, shell-fragments, and metal splinters, combined with burning effects from conflagration of structural materials, exploding gases, and escaping steam. The sufferings from the burnings and gross mutilations recently observed in the destruction of the Spanish ships at Manila and off Santiago, Cuba, have been frightful beyond description; and though official statistics are not yet attainable, it is known that there have been several instances where from 30 to 70 men have been destroyed by the general effects of one exploding shell tearing along between decks, the injuries, wounds, and mutilations partaking of the nature indicated above.

Methods of Transport of the Wounded.—The question of transport of the wounded in action is not easily answered, and has by no means been solved by any naval power. Up to this time no one of the theoretically perfect plans of ambulance drill, including the use of stretchers of many patterns, slings, jackets, chairs, inclined planes, sliding bar, attached to rope and tackle at hatches, has been found practically useful amidst the turmoil and confusion of actual battle. All these contrivances have been, as a rule, designed in connection with types of ships now obsolete, and, from the writer's point of view, without taking into account the real conditions at that time of stress. They nearly all require too much time and too many hands to manipulate, take little account of the present lack of roomy hatches and ladders, and their authors seem oblivious of the terribly destructive fire of small-caliber machine guns. During time of peace the transport of an injured man about a ship offers but little difficulty, and these appliances answer very well. With plenty of time and willing hands no naval surgeon experiences any difficulty; but in the preparations for battle in modern ships there remain no sheltered clear spaces, no unobstructed hatches: while the cross bulkheads with narrow, water-tight steel doors and high sills all prevent the application of these theoretically attractive ambulance methods. Every hatch is, as a rule, in urgent use as an ammunition supply from the magazine below, and this in accordance with the naval maxim that the greatest possible weight and rapidity of offensive fire in the minimum of time win battles. Before

the time when this modern enormous capacity of machine rapid-fire and great gun fire was fully developed, elevators and similar methods were regularly installed in some large ships abroad; but upon trial these failed to remove from the battery-decks to positions below but a tithe of the number of men that, judging from statistics, would fall in an ordinary naval conflict in the time allotted.

During the International Medical Congress, Military and Naval Section, at Rome, in 1894, a number of appliances for transport of wounded in ships were shown, and the conclusion of the general discussion was to the effect that none was satisfactory; and that the time

FIG. 459.—Sliding bar (Stitt), U. S. Navy, for use at hatches; patient in mattress and hammock.
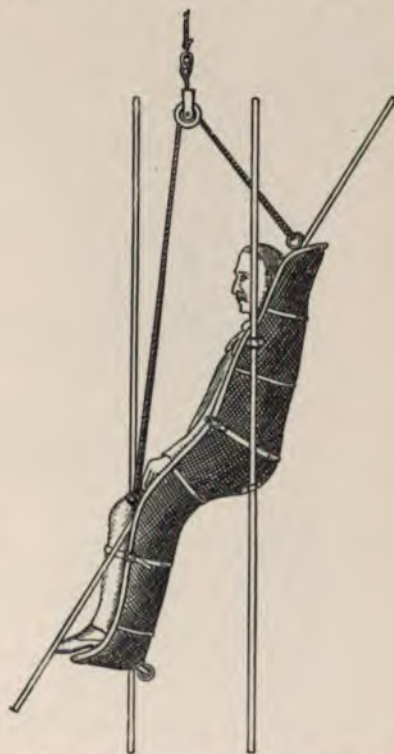
FIG. 460.—The "gouttiere de Bonnet," for use in hatches.

of battle, type of ship, and the circumstances in each case would have to guide the surgeons in method and practice. The consensus of opinion is to-day that each ship must devise its own peculiar ambulance drill, including the most appropriate appliances, stretchers, and system of transport. The majority favor hand-carriage methods, teaching and drilling the bulk of a ship's company "first aids," and how to carry a wounded comrade, by one, two, or more bearers, to a contiguous place of refuge, if any such exist, away from the tumult of the guns. Grouping of wounded in spaces unprotected by heavy armor would expose them to very probable destruction, as has frequently

happened. The closed protective (armored) decks of modern ships preclude going below the water-line in action; and, the magazine and engineer's divisions being below it, these men with those in the turrets are obviously out of reach of the surgeons.

The U. S. Navy is supplied with plain canvas stretchers, canvas cots, and a sliding-bar contrivance for sending men down hatches. The plain stretcher (Wells) is of stout canvas, 2 feet by 6 feet, transversely slatted with narrow, flat oak-wood strips, the side bars passing through a doubled edge. It is a capital stretcher, and without the side bars can be made into a very good apparatus for passing men up and down hatches, by simply running five lines from each side to a central ring over the patient, upon which the rope and tackle fasten. Any desired position, as in a reclining chair, excepting the straight one, can be secured by lengthening or shortening these side lines. The cot (30 inches by 76 inches),

FIG. 461.—Lowmoor jacket on mattress and ham-mock.

FIG. 462.—Patient in Lowmoor jacket, mattress, and hammock, for sending down ladders or hatches.

Gorgas, kept rigid by a pine frame at the base, has ample size, and is suspended by the elon-gated ends to the beams overhead in ordinary use. The four parts lace up at the corners, and, being long, easily cover in a patient securely for transport. The sliding-bar (Stitt) suspended over a hatch keeps the patient extended in transit. The patient is supposed to be wrapped in mattress and hammock, the rings at the ends of the hammock snapping into catch-hooks at each end of the bar, the latter allowing any degree of inclination according to the situation of the tackle on the bar. As before mentioned, the fatal objections to these hatch contrivances are that there are no available hatches, no free decks to drag a man along, men and guns are usually in turrets, and the necessary men cannot be spared to operate them, even if feasible.

Provided the battery is all on one clear deck, the plan of sliding a cot stretcher along the deck to a hatch, and down it upon an inclined plane to the surgeons on the deck below, is recommended, as it

involves no delay, and but few hands. The cot stretcher, with its ample side folds, is simply laced across the patient, while a thin pine bottom forms the base.

If there is a hatch that can be placed at the disposal of the surgeon, there must be rigged a rope and tackle over it, for possible use ; and for this purpose the sliding-bar with hammock and mattress (Fig. 459), the Lowmoor jacket stretcher (Figs. 461, 462), the various plain slatted stretchers rigged to a ring with side lines, inclined chairs, or some similar contrivance, according to the fancy of the surgeon in charge, may be included in the ambulance methods and regular drill of the medical department of the ship.

The "gouttiere de Bonnet" (Fig. 460), made of woven wire or bamboo, with wheels, poles, and hoisting tackle ; cots devised by Gihon and Gorgas, U. S. Navy ; Pohl's stretcher, folds in the middle ; P. W. Mowll's inclined chair, not unlike steamer chair, which, with handles, becomes a stretcher, or, by straps running to a centering ring, serves as a cot in passing through hatches ; McDonald's (R. N.) rather complicated stretcher, cot, or chair, of oak wood, copper, and leather straps, are also among the better known appliances. Variations of the Lowmoor jacket applied to hammocks, and plain stretchers, are common for this purpose, and it secures the patient firmly in transit.

All naval services have evolved stretchers for this purpose, and they have a certain general applicability ; but they are of limited use
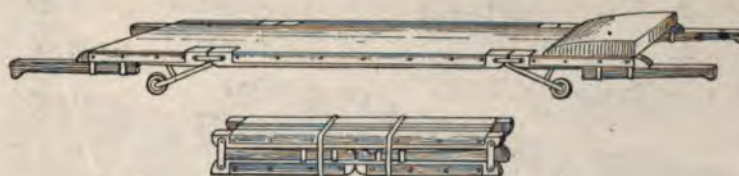
FIG. 463.—Furley's stretcher, ready for use and folded.

in the most modern types of war-ships, for the reason that cellular construction, small hatches (with none at the disposal of the surgeons in action), frequency of turrets, and other conditions present render their use impossible in the hour of need and battle. In the modern battleship at battle-quarters, the personnel vacates all unprotected compartments above the water-line, and there is only the most limited space for the surgeons and their paraphernalia. The surgeon's station or stations are located contiguous to the greater number of the men, with his assistants, operating-table, and chests of supplies strewn around him. In some ships he cannot reach more than a third of the fighting men, by reason of lack of hatches, and the usual passageway being at this time closed by armored plates or water-tight doors.

In consequence, the only available method left is the transport of wounded by hand-carriage, aided mainly by the men who are within reach of the sufferers at the moment of the injury. To provide for this we are compelled to teach a large proportion of the ship's company "first-aids" and hand-transport methods. In the battle of the Yalu this was found to be the only practicable method. This training, systematically carried out and constantly drilled in the men, will answer the purpose of removal and transport of the injured, wherever placed, even from amid the machinery and fire-rooms, following any of the

numerous accidents in those localities. The steep ladders in parts
below are not more difficult than the various upper decks, turrets, and
gun positions elsewhere in the ship, and two carriers can be taught so
to transport a man. At the surgeons' stations, selected with good
light-possibilities (including electric light and a water-supply), must be
placed the main supplies of dressings, drugs, operating-table, restora-
tives, solutions, stretchers, and first-aid materials; and, as far as the
space allows, the wounded may be collected, presuming the locality be
within armored protection.

It will be seen that in the construction and unavoidable disposition
of space in the most modern type of war-ship it is impracticable to do

FIG. 464.—Hospital of U. S. Battle-ship " Massachusetts." Permanent berths, portable oper-
ating- and instrument-tables. Designed by Medical Inspector C. A. Siegfried, U. S. Navy.

much more than to assist the wounded where they fall, with such
limited removal from their guns to unused corners and passages as is
possible. Consequently, only the most urgent surgery can be done
during battle, and everything must wait, excepting the swift and skilful
practice of "first aids" in arresting hemorrhage and applying first
dressings of an antiseptic character. Owing to the deadly secondary
battery fire, composed of machine guns, any unnecessary exposure of
the body is suicidal. It has been the writer's custom for the past four
years to teach extensively the crews of ships the methods and prac-
tice of "first aids" as follows: The men, to the number of fifteen at a
time, are drilled in the handling of tourniquets and improvised means
of arresting bleeding, the physiology of the breathing and circulation,

the lifting and handling of an injured man, the use of the Esmarch triangle and bandages, the reason for antiseptic first dressings, and the methods of artificial respiration. The guns' crews and divisions throughout the ship are supplied with canvas bags containing "first-aid" packets of antiseptic dressings, tourniquets, and bandages. Tourniquets are regularly made with screw, buckle, and the large U. S. Navy vulcanite oval with linen strap to tie; and others simpler, of rubber tubing ($\frac{5}{8}$-inch, in 20-inch lengths), and of bandage with stick windlass pattern. Wherever vacant spaces exist a few hammocks with mattresses are strewn; and finally the surgeons and assistants are equipped with bags strung over the shoulder filled with dressings, and including a case of hemostatic forceps, etc.

Most of the men are keenly alive to the value of "first-aid" instruction, and when not imperatively needed at their guns constitute a large body of willing aids and bearers. The number of bearers regularly appointed and specially drilled to assist the wounded varies, but in the U. S. Navy it is commonly about 12 per cent. of the personnel.

Following an engagement, the more serious and prolonged work for the surgeons will begin. The question of adequate room will now no longer obstruct care and management, and a part of the ship with good light and air may be selected for operative procedures. As much space as is needed must then be given up for the improvised beds of the wounded until they can be transferred to the hospital ship or hospital on shore. It is imperative that the ship must be rid of her disabled men as promptly as possible. The type of ship controls the system to be employed by the surgeon and his opportunities for usefulness, and without armor or other protection from an enemy's fire the modern naval conflict will be a shambles, combined with a burning and sinking. Within the radius of the explosive effects of the modern shell metal, fuses and other materials take fire, while its innumerable fragments form so many deadly missiles in all directions from the explosive center.

Hospital Ships.—The United States Government has the distinction of being among the first nations to equip and attach to an active squadron at sea the typical hospital ship. There have been hospital ships in the great fleets of past wars, transports for the sick and wounded without number in military and naval operations in distant seas, and stationary hospital ships are moored in many colonial harbors; but, in the strict sense, "hospital" or "ambulance ship," as now applied, means a vessel sailing under the protection of the laws of the Geneva (Red Cross) Convention; such a vessel was equipped, and engaged in her beneficent work in Cuban waters. This vessel, named the "Solace," was without any offensive or defensive power whatever, and was very fully and thoroughly fitted for all possible medical and surgical work. She is now (1899) on duty with the U. S. fleet in the Philippines.

In the great French fleet of Admiral Tourville, 1693, in the reign of Louis XIV., the ambitious Richelieu had gathered together 190 ships of all classes and types, including 3 hospital ships. This was the acme of French naval power, and there were 7654 guns and 44,711 men in the fleet. The number of casualties and cases of disease in such a large aggregation of sail-power ships was extremely large—far beyond the present rate. Naval operations, even up to 1840, were attended with disaster mainly from neglect of the ordinary medical and surgical preparations and foresight; and it is not uncommon to find the voyages
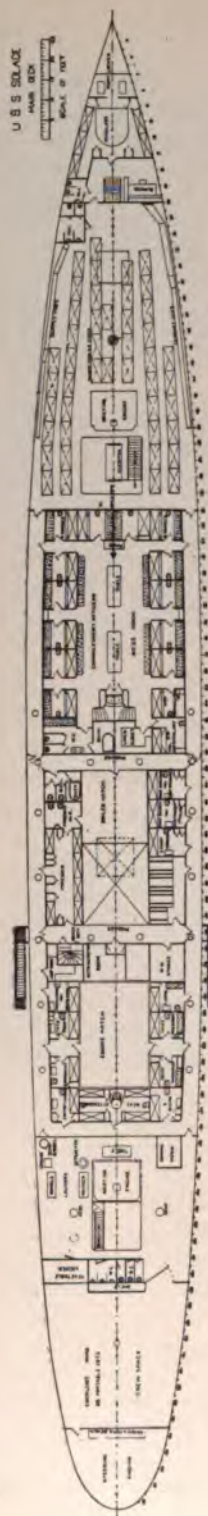
FIG. 465.—Plan of main deck of the U. S. ship "Solace."
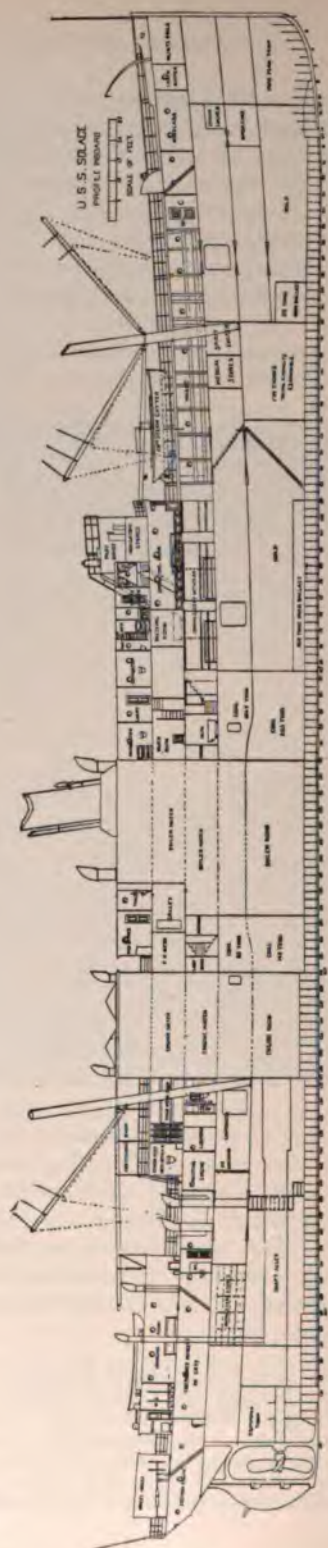
FIG. 466.—Profile inboard of U. S. ship "Solace."

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of ships and fleets, in war or in cruises of exploration, to be long narrations of frightful suf-
ferings of their crews from unhealed wounds, deformities from broken bones, scurvy,
dysentery, and pestilence.

Accompanying the Japanese fleet, at the battle of the Yalu, in 1895, there was a well-
equipped ship used for hospital purposes, stated to have been previously a splendid passen-
ger ship of the Japanese merchant marine. At the close of the battle the wounded were
transferred to this vessel, thus leaving the fleet free to engage the Chinese ships in the morn-
ing without being embarrassed by the presence of sick and dying men. During the battle
one Japanese cruiser, passing between two Chinese ironclads, thus suffering great loss,
transferred her wounded to the hospital ship and resumed her position in the main squadron,
using her guns until the end of the fight.

The U. S. naval delegate to the Moscow International Medical Con-
gress in 1897 presented a paper with detailed plans of a hospital ship.
Before such a ship could be provided, war between the United States
and Spain was declared, and the former government at once purchased
a fine, nearly new merchant steamer, and speedily adapted her for ser-
vice with the North Atlantic fleet in the West Indies. With the Span-
ish fleet that came from Spain after the war was declared, there was
also reported to be a hospital ship, the " Alicante." The writer cannot
obtain any definite information of her, her equipment, or whether she
was properly under the Red Cross or Geneva Convention laws.

The ship selected by the U. S. Navy Department, altered, fitted, and
equipped according to the instructions of Surgeon-General Van Reyden
(who had been the naval delegate to the Moscow Congress the year
before), may be described as follows: Single-screw steamer of 3800
tons displacement, originally intended for the coastwise merchant trade
of North America. Sufficient of her fittings, bulkheads, and passenger
and freight accommodations were removed from the available three
decks to provide spaces for cots and berths for patients, many in dou-
ble tiers, with free passage-ways on all sides, including an isolation
ward for infectious diseases. Total accommodation, 250, with a possi-
ble maximum of 350 patients, with 13 cabins for officers. A large light
operating-room, on an upper deck, is appropriately equipped with ster-
ilizing apparatus, two U. S. Navy portable operating-tables, and the
usual modern surgical appliances and furniture. There are also a steam
disinfector, diet-kitchens, mess-halls, two dispensaries, offices, laundry,
ice-machine (Allen patent compressed air), cold-storage rooms, water-
distiller, and filter. An elevator in connection with trolleys and wheeled
stretchers, two steam and six towing barges to act as field ambulances,
are also provided.

The medical personnel consists of four medical officers, three apothe-
caries, eight trained nurses (male), and the requisite number of cooks
and attendants. The berths are 26 inches by 75 inches, wooden
frames, woven-wire springs, and hair mattresses. Convalescents have
the use of the upper deck, light, airy compartments, and spaces for
lounging. The ship's personnel, including the men on deck and in the
engine-room, exclusive of medical personnel, is less than seventy men.

Probably a better hospital ship would result from an original con-
struction designed wholly and in detail for the purpose. Lightness
and improved appliances in berths, cots, and hospital furniture, subdivi-
sion of space, the use of steel and iron materials for framing of berths,
more height between decks, and a model of ship giving broader beam
to length than is common in the merchant marine, for greater stability

and buoyancy in rough weather. The question of speed is debatable. Moderate speed only is necessary, and a high speed entails the use of much valuable space, and is responsible for an overheated structure from the disproportionate amount of machinery and steam appliances required, while all noises are accentuated.

The "Solace" has an average speed of 14 knots per hour, with a maximum of 17 knots. Steaming radius, 5000 miles, and a coal capacity of 900 tons.

The cost per berth, or per patient, of a hospital ship will range from $1200 to $2250. By the experience gained in the Spanish-American War in fitting out several hospital ships by civil aid societies and by the United States Government, it is found that, following the original cost of an appropriate merchant steamer of between 2000 and 4000 tons displacement ($300,000 to $500,000), the cost of equipment for hospital purposes must be put at from $50,000 to $60,000; and the running expenses per month under ordinary circumstances will be not less than $10,000. The total expenses can be made to range widely, according to quality of fittings and desires of those in control; but it is quite possible to equip and put in service a hospital ship, with sufficiently ample and comfortable detail in every department, commensurate with modern scientific requirements, in caring for and treating sick and wounded men, for the sum of from $1200 to $1500 per fixed berth. This must include: metal-frame berths, 26 inches by 72 inches, with spring and hair mattress in a well-ventilated compartment, a proper hospital cuisine, baths, lavatories, disinfector, sterilizer, operating-room, offices, ventilating-plant, ambulance appliances, boats and barges, and ice-making plant with cold-storage rooms, laundry, mess-rooms, and all the detailed necessities in connection with a modern hospital. Air- and floor-space is much dependent on height, ventilation methods, and capacity; but, as a rule, the amount of cubic space can be given as from 150 to 350 cubic feet per berth. As an illustration, the Massachusetts Volunteer Aid Association, in this war, equipped at its own expense a hospital ship of 900 tons, with 92 fixed berths, with a maximum accommodation for 140 patients on emergency. This ship contained all of the facilities mentioned above, and the total cost was not over $115,000—*i. e.*, in round figures $1200 per fixed berth.

The station of the naval hospital or ambulance ship should be with the fleet, or its greater part. In battle a safe distance from the combatants would be essential, while the opportunities for rescuing men from sinking ships and removing the wounded from fighting ships, in the lulls of firing or following the battle, would be entirely according to the incidents and circumstances as they occurred during the engagement. Succor would not be withheld from the enemy in his extremity.[1]

Venereal Disease.—Half of the naval surgeon's work in some parts of the world is due to venereal disease. The statistics from 1893 to 1895, German Navy, average strength 20,000 men, gave 504 per mille of the sick admissions from this cause on the China station; and 113.5 per mille on the home station. The annual returns, United States Navy, give a total loss of time equivalent to the crew of a small gunboat for nearly a year. In the large navies of the world, such as that of Great Britain, with an average strength of 60,000 men, the approximate loss would man two or three war-ships for about a year. In some parts of the world venereal disease among crews causes much anxiety, notably so in the East Indies, China, Japan, and in some West Indian ports. Peculiar and effective measures are sometimes adopted to restrict, or even to control, venery among the men. Ships have used islands and villages, women being provided from the natives voluntarily, the authorities sanctioning the whole proceeding. In many vessels, from the undue prevalence of disease in the crew and

[1] See "additional articles concerning the marine," October, 1868, Articles VI. to XV., Red Cross Geneva Convention.

the consequent effects, disabilities, and sequelæ, restrictive measures and systematic surveillance of the individual become necessary. This is particularly so in notoriously lax communities, in the tropical regions of the Orient, and in the West Indies. A very common and effective plan is to prevent all general shore-going in notorious sea-ports, and in ports with good government and some restriction of prostitution freely encourage it. Finally, a certain percentage of men must be inspected before being allowed to go, which soon corrects the very common habit of concealment, and is perhaps the measure of most value in educating men regarding the dangers and accidents inseparable from excessive venery.

With present-day methods, it is rare to meet with intractable cases of local lesions, general systemic infection, and tertiary phenomena. Nor can it be said that cerebral nerve lesions are prominent. Generally speaking, however, syphilis is one of the great causes of the sailor's early senility, arterial changes, and chronic disorders of the mucous tracts and passages, notably the genito-urinary apparatus. Combined with the constant liability to venereal infection is the tendency to excess in alcohol, characteristic of many seamen. These two unhappily constant causes obstruct their even and normal lives, and must be reckoned with by the medical officers of all naval services. The economic importance of this subject, together with the ultimate costly invalidings and pensionings of men broken down early, cannot be overestimated.

Restrictions of crews in presence of threatened infectious disease of other classes, such as cholera and yellow fever, and of malarial disease, are easily enforced and are the rule; yet there is an unwillingness to restrict crews against this really more general and insidious enemy.

Heat-exhaustion, or "heat-stroke," must be looked for upon occasions of arduous continuous labor in the engine- and fire-rooms in warm weather, and a ship may be seriously crippled from this cause. This does not at once appear, but does after a day or two following the strain of unusual work and heat conditions. Temperatures of from 112° to 140° F. are common in fire- and engine-rooms, varying at the different localities and elevations; and in a small proportion of the high-powered ships the writer has reported upon fire- and hydraulic rooms with temperatures of from 135° to 196° F. In these latter superheated spaces the men remained only a limited time at work, and sought the cooler contiguous passages in the intervals. However, a number of collapsed men, some unconscious, were removed from these spaces. Oatmeal, thinly dissolved or mixed with water, is the usual thirst-assuaging drink of firemen, sometimes slightly iced. If the interval or rest-period between watches is made longer, with complete relaxation in the open air, the working period shortened, and a small amount of stimulant occasionally given, heat-exhaustions may be much limited, and even avoided. The better plan is to shorten the working period (the labor is "extreme muscular exertion"), reducing the watch from four to two hours, with as long a period off as is possible to give.

The condition of a man prostrated from heat-exhaustion is typical of nearly complete collapse of circulation and respiration, with partial or complete unconsciousness. He is pallid; the skin clammy; tem-

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perature may be subnormal, or not over 102° to 103° F.; pupils slow
to react; there may be convulsive muscular movements; and if he is
conscious, he complains of headache and cramps in the muscles of the
legs. In rare cases the temperature goes higher, the skin is hot and
dry or moist; there are unconsciousness, muscular spasm, irregular
heart-action, and sighing or jerky respiration.

The **treatment** depends mainly upon the body-temperature (taken
in the rectum) and condition of the circulation. Cold affusions, ice and
frictions, and cardiac sedatives hypodermically if the temperature is
excessive; warm applications and dry frictions, with cardiac stimulants,
with depressed or normal temperature and failing powers. Cases must
be individualized and treated symptomatically. Bleeding is rarely called
for, cases being seen early. Cooling affusions with frictions and cardiac
stimulants, such as strychnin hypodermically, restore most cases. The
worst ones require energetic treatment to reduce temperature, relieve
cerebral congestion and stasis, and to keep up the functions of the
heart and breathing. Long periods of rest must follow the attacks,
with tonic nerve treatment. Attacks are liable to recur in the same
subject. The prognosis is good, as a rule. Recovery may be delayed
some weeks; in bad cases, months. Inexperienced men soon fail in
the fire-rooms of the modern war-ship in the warm season; and under
usual conditions the lives of firemen in high-powered ships, the active
working lives, are reduced to a period variously estimated at from
eight to eleven years. In threatened heat-exhaustion, or " heat-stroke,"
it is customary in many ships to issue alcoholic stimulants to the men
when at work, and the practice may be justified for a limited time only.

CHAPTER XXXII.

THE TRAUMATIC NEUROSES.

Definition.—The term "*traumatic neurosis*" is justifiable only as a collective designation of the various functional disorders of the nervous system which follow injury. It does not denote any special forms of disease.

The word "traumatic" formerly conveyed the idea of bodily injury alone; but it is now generally understood to include many cases in which "nervous shock"—that is, the derangement of the nerve-functions due to a sudden and severe emotional strain—is usually the essential factor.

It is also worthy of notice that the expression "traumatic," as here used, does not always have the same clinical significance. Chorea and paralysis agitans, for example, present essentially the same features, whether they be of traumatic origin or not; while, on the other hand, many cases of the hysteroid psychoneuroses that follow accidents present more or less distinctive features, just as the mental states of a number of persons who have been exposed to similar social influences, or who have received similar post-hypnotic suggestions, are likely to resemble each other within certain limits.

Many affections besides the psychoses and neuroses are, of course, met with after accidents; but these affections will be here referred to only to the extent of indicating how far they are of nervous origin. One must, however, recognize that while practical considerations oblige us to confine ourselves mainly to the neurotic conditions that are especially common after injuries, yet we are in reality dealing with an agency which has an immense range of possible action for harm, the principles of which we are bound to make an effort to understand.

It must also be recognized that although the study of the localized lesions of the nervous system and their effects belong, strictly speaking, elsewhere than here, yet, in fact, we are not always able to tell whether such lesions are present or not, nor what part they play as etiological factors.

ETIOLOGY.

It is important to consider here not only what kinds of trauma are the commonest antecedents of the neuroses to which we have referred, but also what are the special agencies by which the results are brought about, and the mode of their action.

One of the commonest causes of accidents is *railroad collisions.* These furnish the cases in which jars and concussions, often of great violence, occur; and they are also of importance because they have come to be associated in the public mind with a special sense of terror.

Another important class embraces *local injuries to the head and back*. These are more important than injuries to the limbs, both because they are more often the cause of lesions of the central nervous system, and because their emotional effect is so much more profound. In the case of the head-injury, this latter effect seems to be due, in part, to the fact that patients are peculiarly unmanned by the sense that the brain may have been damaged. In the case of injury of the back, strains of the muscles and ligaments are likely to occur which are painful in themselves, and thus inhibit motion, and also excite a fear of deeper spinal injury.

A third class includes the cases in which some intense emotional state, as *fright or anxiety*, is induced, without being attended by bodily injury. Strictly speaking, these are not traumatic cases in the usual sense of the word; but it is essential that they should be considered in this connection, partly for the sake of comparison and partly because emotional excitement exerts such an important influence even in cases in which the bodily injury seems at first sight predominant.

Electrical injuries have become of late years of greatly increasing importance. They are of especial interest because they afford the opportunity of studying a class of cases in which consciousness is almost instantly lost or profoundly altered, and in which the character of the lesions, when such occur, is different from that seen in other cases.

What are the special agencies by which these different kinds of accidents effect their results? The tendency has been growing during the last few years to attribute more importance to emotional excitements, and less to actual lesions of the nervous system. It may be said in a more general way, however, that two sets of forces are brought into play in every accident. The first set embraces all those which make it difficult for the nervous system to work on its accustomed lines; the second set embraces those which tend to establish a sort of new equilibrium, though often a very imperfect one. From this point of view I purpose following the arrangement of etiological agencies in the order of their importance.

A. Predisposing causes:

1. Of neuropathic character. 2. Of "social" character. 3. Of toxic and nutritional character.

B. Influences operative at the time of the accident:

1. Fear, panic, emotional excitement, and mental strain. 2. Painful or disabling injuries, such as sprains of the back or blows upon the head, not severe enough to cause deep loss of consciousness, yet sufficiently so to impair the voluntary control. 3. Injuries sufficient to cause deep loss of consciousness, such as powerful electrical shocks or severe blows on the head, or such as presumably interfere, by severe concussion, with the nutrition of the nervous system. 4. Injuries of a kind to cause actual lesions within the central nervous system. 5. Slighter bodily injuries, even down to physical contact, if they are only of a kind to excite or increase apprehension of danger.

C. Influences operative after the accident:

1. Secondary inflammatory, degenerative, and nutritive disorders. 2. Excitements and anxieties of diverse sorts. 3. The effects of emo-

tional excitements due to reproduction in memory of a past danger. 4. The continuance of pain, and the depressing effect of internal disorders, such as sprains, uterine displacements, etc. It is to be noted that from the fact that such affections as these have arisen in a given case as the result of an accident, that they often become clothed with a special power to cause and perpetuate nervous derangements. Some of these influences need to be described at greater length.

Predisposing Causes.—1. **Neuropathic Tendencies.**—There is no doubt that influences of this sort are of some importance; and many of the patients who become chronic hysterics and neurasthenics after accidents are obviously only working out their "manifest destiny." It is, however, certainly true that in the great majority of cases, including many in which apparently trivial accidents have been followed by very severe results, no neuropathic tendency, in the usual sense of the term, can be detected.

2. **Social Characteristics.**—Every physician who has had occasion to examine any considerable number of cases of post-traumatic hysteria and the typical neuroses, especially those which find their way into courts of law, must have noticed that the great majority of the patients are persons of small incomes and such as have led, socially speaking, narrow, restricted lives, without having had much opportunity for general cultivation and experience with the world, and without many resources in the way of pleasure or employment outside of their special occupations. On the other hand, there are several classes of persons that are relatively exempt from the severer forms of the post-traumatic neuroses. Such are (1) those who meet with accidents in the way of sport, or of occupations in which such accidents form a legitimate outcome, or of war; (2) persons with highly trained self-control and cultivated intelligences. Persons of this stamp are more likely to be found among the professional, the leisured, and the higher business classes than among wage-earners and people who live on small salaries.

It is certainly true that the severe accidents of the foot-ball field are rarely followed by nervous symptoms, as Morton Prince's recent inquiries indicate;[1] and it is also striking that severe and typical cases of post-traumatic hysteria are rarely met with among private patients of cultivation and social training.

The relative exemption of persons receiving even severe injuries in the way of sport or in occupations in which accidents are not unlooked for, shows that such results cannot be due, as a rule, or in any considerable degree, to actual lesions of the central nervous system. On the other hand, the greater liability of the poorer and less cultivated classes, even though they are not of neuropathic temperament, and though they have led temperate lives, shows that the training in self-control exerted by society on its members is able, when coupled with knowledge and familiarity with the world, to confer a high degree of immunity. This fact makes it clear that the injurious influence exerted by accidents is one that makes itself felt largely through mental channels.

The greater liability of the poorer classes is also due to the fact that an accident often seems an irreparable disaster to a man of

[1] *Boston Med. and Surg. Jour.*, April 28, 1898.

slender income, spending up to the verge of his earnings. Of course, it is also true that a half-recognized feeling that legal complications are likely to arise, and that a good case must be made out on that account, must necessarily play a more or less important part, even from the very outset, since this idea, like the idea of danger and injury, is contained for many persons in the very conception of the word or thought "accident."

When the people of wider training do fall victims, it is toward neurasthenic states rather than toward hysteria that their symptoms tend. Indeed, results of this sort are probably not uncommon; though we do not hear much about them, because the effects of a particular accident are perhaps mixed up with the effects of a neurasthenic temperament, or with unfavorable influences of divers sorts. (See case cited below.)

When it is considered, in the light of these facts, that the persons who are thus predisposed by their social surroundings to suffer most profoundly from the emotional shock of accidents are likewise forced by their lack of fixed income to go to law for damages, it is, I think, clear why we find a greater number of hysterias in law courts than outside. It might be urged that we ought also to find these same results among hospital patients, but in non-legal cases. To a great extent I think that this occurs; and I believe it would occur more frequently were it not that in the cases in which no damages are obtainable the stern teaching of necessity is likely to force a recovery, provided the disease has not run on too long.

In pursuance of this view, I shall point out under Treatment that the prognosis in accident psychoses varies immensely with the treatment to which the patients are subjected.

3. The influence of previous alcoholism and other debilitating conditions is of marked importance, and the more so from the fact that chronic alcoholism may itself give rise to hysteroid symptoms (Sänger).

Operative Influences at the Time of the Accident.—1. **Emotional excitement** is the most important of these, even where all outward manifestation of emotion has been suppressed. Sometimes, indeed, the suppression of the emotion increases the ultimate effect, while perhaps obscuring its origin. A case of this kind is the following:

A lady, twenty-two years of age, spirited and courageous, though perhaps slightly nervous in temperament, was run away with while horseback-riding, and eventually thrown off, so that for a few minutes she was stunned. She stayed in bed for two or three weeks, but then insisted on getting up, and went about as usual, though suffering continually from backache. It was found later that she had a retroversion of the uterus, possibly dating from the time of the accident. Later, she had another severe nervous shock from witnessing the narrow escape of a young girl from drowning, and gradually, from all these causes combined, she fell into a condition of nervous weakness, from which the best of treatment has not been able to free her, though she has obtained considerable benefit from a species of mental hygiene.

2. **Injuries of the head and deep-seated strains of the back,** even if not in themselves of serious import, are often peculiarly prostrating, partly because they excite apprehension lest the organs of the central nervous system have suffered irreparable damage, as in the following case, which was not complicated by a suit:

A hospital patient, an intelligent Hebrew, had been struck on the head by a heavy hammer thirty-three years before I saw him. He was not stunned, but lay in a hospital for some weeks in a " very low " state, yet with no special symptoms except pain. This pain had continued and increased, so that he sought relief by operation. He was said to have lost flesh and not to have slept well on account of the pain, but his appearance suggested perfect health, and repeated careful examinations of the site of injury revealed nothing abnormal, although even the lightest touch on the scalp made him scream.

It is well known, of course, that even moderate injuries of the head and back may cause actual lesions, to be followed by degenerative changes, and these will be discussed farther on; but I desire to call attention here only to the psychoses and neuroses that are likely to result. The following case illustrates an especially interesting form of hysteria arising on the basis of a strain of the back, and strongly suggesting Pott's disease with pressure-myelitis :

A mechanic was struck on the neck and shoulders by a heavy plank falling from a height of about 12 feet. He was doubled over and temporarily stunned, but received no severe injuries. Pain in the back came on in the course of a few hours, associated with rigidity, weakness of the legs, highly exaggerated knee-jerk, and ankle-clonus. The patient was still in this condition when I saw him a year later. Careful investigation of all the circumstances made it clear that the case was really one of hysteria, an opinion which recent developments have confirmed.

The greater number of the cases of painful and rigid back which follow moderate jars and concussions have this element of hysteria behind them.

3. **Concussion of the Brain.**—It is still uncertain, in spite of the experiments of Duret, Horsley, and others, to what agency the loss of consciousness and paralysis of function of the brain-cortex and deeper-lying parts is due in cases of severe blows and concussions. Probably, indeed, various causes may produce these results. Anemia due to the displacement of blood from indentation of the skull is one of them; while inhibition, vasomotor disorders leading to loss of vascular tone (Friedmann, Fischer), and perhaps the physical and chemical changes in the nerve-cell, excited by powerful mechanical vibration, are others.

Electrical Injuries.—The subject of electrical injuries has been carefully studied within a few years by Biraud,[1] and his conclusions, some of which I partly cite, are still valid. " The mechanism by which death is brought about by electric currents of high tension is not yet fully clear. It is probably due to asphyxia following the arrest of function of the medullary centers for the heart and respiration. . . . The clinical study of accidents of this kind shows that hysteria of the usual type is an occasional result." It is noticeable, however, that it is not so much the very severe injuries of these sorts, attended by complete loss of consciousness, that excite hysteria, as it is the slighter accidents in which consciousness is partially preserved.

4. The question whether **actual lesions of the central nervous system** play an important part in producing the traumatic psychoses and neuroses has been a matter of much discussion. There can be no doubt that injuries, even of moderate severity, such as falls unattended by fracture, are capable of causing actual lesions of the nature of minute hemorrhages, necrosis of nerve-elements, and, perhaps, as has been recently asserted, of important and widespread vasomotor disorders and vascular degenerations.[2] The usual outcome of these

[1] La Mort et les Accidents causés par les Courants électriques de haute Tension.

[2] See Koppen (*Neurol. Centralbl.*, No. 20, 1897), and especially the recent and important paper by Fischer (*Deutsche med. Wochenschrift*, p. 569, 1898), on *commotio cerebri* and its relation to small hemorrhages, in which it is pointed out that the loss of vascular tone due to the nervous shock of injury may lead to irreparable and progressive vascular degen-

lesions is, however, either in recovery or else in recognizable forms of inflammatory or degenerative processes, rather than in the neuroses and psychoses properly speaking, though it occasionally happens that typical psychoses and neuroses constitute the only manifestations of such lesions, just as they are sometimes the only signs of cerebral tumors. On the other hand, the occurrence in hysteria and kindred psychoses of symptom-groups which would formerly have been thought to occur only on the basis of gross organic disease is being more widely recognized. We have the hysterical "intention-tremor," the hysterical paralysis agitans, the hysterical neurasthenia, the hysterical spastic paraplegia, and other hysterical disorders of like character.

5. But if it is true that actual nerve-lesions rarely count as direct causes of traumatic hysteria, it is equally true that **physical violence, even of the most trifling character,** may have an indirect influence of great importance in intensifying the symptoms, provided it is capable of disconcerting the patient so that he is less able to exert the protective force of the will, or of impairing his sense of confidence, or increasing his apprehension of more harm to come. This is of especial importance in judicial districts where, as in Massachusetts, it is usually impossible to recover damages for pure fright, but possible to recover where the symptoms are partly due to physical causes, no matter how slight the injury may be. Even physical contact may justly be rated as a cause in this sense. It is a trifling thing, for example, to be shaken by the collar; but if this should be done unexpectedly when one was crossing a crowded street and bent on keeping a sharp lookout for swiftly moving teams, the effect might be very serious. Likewise, although we brush daily, without emotion, against hundreds of persons in the street, it is easy to imagine circumstances—the knowledge, for example, that one of these persons was irresponsibly drunk and carried a loaded pistol—when one of these contacts might excite terror, and materially increase the effect of mere propinquity.

Influences Operative After an Accident.—It is obvious that the **excitements and anxieties** which come with memories and reflections after an accident must act as contributive agencies in causing nervous symptoms. Among these unfavorable influences are those associated with attempts to obtain damages by suits at law, such as indignation against the causers of the mishap, a desire for gain, the mischievous influence of friends or lawyers, or the fatigues attendant on the law's delays and the scenes of the court-room. It is only by conscientious study, based on expert knowledge, that each of these and similar influences can be assigned its due share of the result, and it often happens that a satisfactory analysis is impossible. The reproduction in memory of a past danger may bring on a series of symptoms that did not follow the accident itself. A striking case of this sort is recorded under Symptomatology.

eration. Similar observations with regard to the vascular system were made some time ago by Friedmann (*Arch. für Psych. u. Nervenkr.*, vol. xxiii.), Sperling and Kronthal (*Neurol. Centralbl.*, 1889, *über latente Arterio-sclerose*). See also observations and references given under Symptomatology. It is by no means improbable that the impairment of vascular tone which follows strong emotional shock is occasionally followed by similar results.

A few words may be added about the depressing effects of **continued pain** and the irritation of internal disorders caused by the accident. It is a fact of common experience that the injurious effects of local pains and irritations are trifling or serious according to the general susceptibility of the patient. Many women, for example, retain good health in spite of having a retroverted uterus, though to others such a displacement would be a cause of great distress. This same observation is noticeable in post-traumatic cases. Sometimes after a patient has improved, but where the recovery is still delayed on account of the habit of disease, a new cause for effort and encouragement may be found in judicious uterine treatment, if this is called for, the patient feeling that at last the real cause of illness has been found.

SYMPTOMATOLOGY.

In accordance with the plan sketched out under Etiology, I shall classify the symptoms and symptom-groups as representing, first, the disorganization of nerve-functions due to the shock of the accident; and second, the action of new forces to which this disorganization gives rein, and which may be said to tend toward the establishment of a new equilibrium within the nervous system, taking the form of disease. In other words, it is plain that two kinds of forces are at work in these cases, one tending to cause *symptoms of defect*, the other to cause *symptoms of reaction*, which the defect renders necessary or possible. These latter symptoms might be called *symptoms of substitution*. Thus, the general course of a case is usually somewhat as follows:

The *first stage* is characterized by the depressive effects of the shock, preceded either by emotional excitement or by a latent interval of calm. In this stage the symptoms of defect predominate, as indicating the inadequacy of the nervous arrangements to meet the severe strain so suddenly thrown upon them. The shock may be profound, involving deeply the processes of organic life, as in "surgical shock;" or it may only throw the higher cerebral functions out of gear, and thus render the patient susceptible to unfavorable emotional influences associated with the events of the accident. Such a patient becomes like a hypnotized person to whom it is said, "You are to be sick, or lame, or paralyzed as a consequence of this accident." It is in accordance with this view that hysterical symptoms sometimes show themselves immediately after the accident.

This stage of the shock is followed by a *second period*, when conscious reflection and observation begin to play an active part. The patient notices that his nerve-functions are working out of harmony and inadequately, and a sense of exhaustion, incompetence, and helplessness ensues, to which active phenomena are superadded, due to uncontrolled display of nervous energy. The prominence of distressing dreams, the excitability which interferes with sleep, the irritability of the heart, are a few of many examples. If hysterical tendencies suggested by the events of the accident have taken root they will continue to develop during this period; while, conversely, substantial progress may be made in it toward recovery by the re-establishment

of the old equilibrium.   Occasionally, when the shock has affected the "visceral" nervous centers—which may happen even from slight accidents—the patient's nutritional processes and vital innervation may be so compromised that he becomes a prey to illnesses of various sorts.   The contributive influence of alcoholism or other debilitating agencies may greatly increase this danger.

In a *third period*, which is separated by no sharp line from those which precede or follow, the character of the case defines itself more definitely, the symptoms either subsiding and giving place to health or assuming more nearly the features of some special type of disease.

Finally, provided recovery does not ensue, the illness may enter on a chronic stage, which may be called the *fourth period*.   In this stage the events of the accident are still regarded as the cause of the illness; but, nevertheless, the skilled observer finds that their direct domination has ceased.   The patient is a hysteric, a neurasthenic, or a habit-vale-tudinarian, etc., like any other who may have been born to the disease. At this period, also, chronic nutritional disorders, which may have begun even before the accident, are likely to make more rapid progress.

In this brief sketch I have had in mind mainly the commonest types of cases, and have not attempted to indicate the variations which the influence of actual nerve-lesions might make in accentuating the nerve-shock, acting as a center for new symptom-groups, or exciting their own proper results.   This and other obvious gaps will be filled up in the more detailed discussion of symptoms which now follows.

Symptoms Characteristic of the Period Immediately Following the Accident, or Shock-symptoms.—Loss or impairment of consciousness; amnesia; impairment of the functions of organic life.

Impairment of Consciousness.—Nothing is more common than to hear the victims of accidents say that they were made unconscious by the shock which they received, even when this was trifling.   In cases of severe head-injury or powerful electrical shock, or where the action of the heart is inhibited, so that syncope results, it is easy to believe this statement.   Frequently, however, the patient is dazed rather than unconscious; and even where consciousness in the strict sense is in abeyance, the capacity for mental activity of another grade may be preserved, and the patient may even possess a heightened susceptibility to unfavorable impressions connected with the accident.

The patient's own testimony as to the degree to which his consciousness was impaired is not conclusive, and in reality he is probably often in a state of altered consciousness analogous to that induced by hypnotism.   We do not know enough about these states, as developed through accidents, to feel justified in considering them identical with the hypnotic states, but they certainly deserve the name of "hypnoid," and their occurrence is favorable to the formation of subconscious chains of association which may modify the subsequent conscious life to a remarkable extent.

One symptom that apparently, but falsely, suggests a complete loss of consciousness is an inability to recall the events of the accident, which is often seen, and is designated as *amnesia*.   Sometimes this amnesia is for events preceding the injury.   In one such case in my experience, in which a man driving in a buggy was knocked over by a locomotive

and severely injured, it was a long time after his recovery from the primary shock before he could give a clear account of the week or two before the accident, except for a few images, such as the impression of the oncoming of the train, which stood out either as especially important or as anchored by some special association.

An interesting case, as showing how slight a violence can cause amnesia, is reported by Näcke,[1] who was himself the patient. During a ward-visit he was struck by an insane patient so heavy a blow upon his mouth, though with the open hand, that he lost consciousness and fell to the floor, without, however, striking his head. He was picked up and laid on a sofa, but within a few seconds afterward was able, with some help, to arise and walk across the room. He spoke of the accident, talked with other patients, gave directions as to the treatment of his own case, went through a corridor and down two flights of stairs, and then walked to his house, which stood near by. Yet the events of this entire period, covering about fifteen minutes, vanished wholly from his memory and were never regained, only a vague recollection of the blow and the falling remaining. This shows that even where the patient—by his own testimony—loses consciousness, he may retain his capacity for receiving effective mental impressions of a high order.

But if the patient often overrates the degree to which the power of mental activity is impaired, the fact of his behaving in a calm and unconcerned manner at the time of an accident is no proof that his power of self-control is really intact. Further, it is not conclusive that he is not in one of the kinds of hypnoid states previously alluded to as favorable for the reception of subconscious impressions, which may later induce definite hysterical phenomena analogous to the results of "suggestion in the waking state."

Latent Interval.—It is very common for the victim of an accident to appear unaffected for hours or even days, and to think himself uninjured, and yet finally to break down with serious symptoms—vomiting, hysterical crying or convulsions, nervous chills followed by a sleepless night or a sleep broken by frightful dreams, hysterical paralysis, or extreme mental excitement. Sometimes it is not the shock of the accident itself, but the memory of the events which have occurred, that acts as the exciting cause. As a rule, however, a ferment of increasing emotional tension is introduced by the accident, and the apparent calm is due to the holding on of the normal order of things by a sort of momentum. A certain length of time seems to be required before the conscious volition discovers that its power is undermined, and that it is no longer supreme.

A case related to me by a colleague is here in point. A gentleman—a person of intelligence and cultivation—was walking near the precipitous edge of a mountain-top, but without thought of danger, when a companion urged him to be careful and come farther back. This he did, and for the time thought no more of the matter. In the afternoon of the same day, however, after he had descended from the mountain and had dined, and while he was sitting quietly on the piazza of the hotel, he was seized with a sudden terror, based on the event of the morning. He then found that he could neither trust himself on a high place nor even pass beneath a high building without considerable distress. This condition lasted for a long period, and was only dispelled a year or more later by the counterinfluence of a forced climb in the Alps, where a dangerous place was passed without harm resulting.

Another series of *shock-symptoms* are those affecting the *nerve-processes of organic and vegetative life*—the vasomotor, the cardiac, the respiratory, the thermal, the secretory, the gastro-intestinal, etc. A state of prostration is occasionally induced by accidents, even by those which do not cause bodily injury, which is analogous to that of "sur-

[1] *Neurol. Centralbl.*, No. 24, 1897.

gical shock." It is characterized by nausea and vomiting, pallor, chills, slow pulse, coldness of the skin, and low temperature, associated with great weakness, sleeplessness, restlessness, and slight delirium. These signs may be grouped in various ways. Sometimes a brief period of high temperature precedes the low temperature, the latter, however, usually persisting the longer—perhaps for days or weeks. The nausea and vomiting may also persist, often becoming at last a habit-symptom or a symptom of hysteria. Similarly, the acute prostration may pass into a chronic prostration characterized by manifold hysterical and neurasthenic weaknesses, including sexual impotence.

It is probably not always easy for the patient or those around him to estimate the depth of these disorders of innervation of organic life. It is not improbable that some of them may be the indirect cause of the various chronic inflammatory and degenerative diseases which occasionally follow accidents. Such a case, which, however, ended in recovery, is the following:

A woman of twenty-seven, a worker in a factory, was riding in an electric car with which another car collided, though with only moderate force. The patient, overcome with fright, sprang to her feet and strove to reach the opposite seat. Before getting there, however, her legs gave way and she collapsed to the floor. The early symptoms were constant vomiting, great prostration, delirium, subnormal temperature, slow pulse, slow and feeble speech, extreme pallor. As the case progressed, and even from the first, other symptoms of much interest presented themselves, some of which will be referred to later.

It is an important question how this sort of shock, which usually from the outset wears something of a hysterical aspect and may pass directly into a state of typical hysteria, is related to the true " surgical shock." Probably there is no difference except in degree, the hysterical shock causing a less profound involvement of the various centers than true surgical shock, and indicating a less dangerous state than a surgeon might assume upon seeing it for the first time. In the hysterical shock, moreover, sensory and motor symptoms exist from the outset or are quickly added, these symptoms usually establishing the diagnosis of hysteria, and emphasizing the quasi-theatrical element in the situation.

Other early symptoms of importance are *bleeding from the mucous membranes, disorders of menstruation, and incontinence of urine.*

Strümpell[1] has recorded an instance in which blood was ostensibly vomited, but was found on careful investigation to come from the pharynx; and recently[2] another case, in which hematuria was claimed, but in which the patient was discovered to be practising a systematic deceit, sucking blood from the gums and spitting it into the urine vessel. The consideration of this case properly belongs with the study of the mental symptoms of hysteria, but it is introduced here as suggesting the need of care in drawing conclusions.

It is claimed with justice that the tendency to deceive lies close to the surface with some hysterics, and passes over by insensible gradations into hypochondriacal exaggeration.

In the case of my own just cited, blood was apparently vomited for several weeks, sometimes in considerable quantity, and this process was once witnessed by the attending physician. A chemical examination of one specimen of this blood showed an absence of hydrochloric acid and peptones, but the specimen was not perfectly fresh.

[1] "Ueber hysterische Hämoptoë, inbesondere bei Unfallkranken," *Monatssch. für Unfallheilkunde,* 4, No. 1, S. 1, 1897.
[2] "Simulation von Blutbrechen und Hämaturie bei einem Unfallkranken," *Monatssch. für Unfallheilkunde,* 5, No. 4, S. 97, 1898.

The *menstrual function* is often affected temporarily or permanently by the shock of accidents. Menstruation in progress is usually checked; if not in progress, it is often brought on prematurely. Likewise, functional pelvic disorders, such as *ovarian neuralgia*, often arise, together with various hysterical symptoms, and subsequent menstrual periods are often attended with pain.

Incontinence, or rather dribbling, of urine, usually of slight amount, is occasionally complained of during the early stage, but rarely, if ever, persists.[1]

As the immediate effects of the excitement and nervous shock and injury of an accident pass away, or even while they are in full force, new features may show themselves. These are the *secondary* or *indirect results of accidents—i. e.*, **substitution symptoms.** They may be classified as: 1. Diseases of organs other than the nervous system arising in consequence of impairment of innervation. 2. Diseases of the nervous system arising as in the last case, but due to some other prominent cause besides the accident. 3. Diseases of the nervous system of which the accident is the main or only obvious cause, except general predisposition, though other influences may act as accentuating causes. 4. Certain diseases of serious character, but of obscure causation, to be specified later.

The *first group* comprises diabetes, the dermatoses, progressive pernicious anemia, the chronic cardiac and arterial diseases, and kindred disorders. It is not easy in a given case to be sure how large a part was really played by the antecedent trauma, but the circumstantial evidence that this may exert a great deal of influence is fairly strong. As regards the case of *diabetes*, Ebstein,[2] as the result of the analysis of 50 cases of diabetes occurring at varying periods subsequently to accidents, concludes that trauma must certainly be reckoned as one of the causes of both glycosuria and diabetes—both diabetes mellitus and diabetes insipidus.

In many cases in which this result occurs there exists a predisposition to diabetes or a neuropathic predisposition. Acute cases of post-traumatic diabetes may end in recovery. The nature of the relationship between the injury and the disease is not clear; nor is diabetes habitually a result of the hysteroid neuroses such as are the subject of this article. On the contrary, in most of Ebstein's cases diabetes occurred independently of the traumatic neuroses, and where the two occurred together the relation seemed to be one of concomitance rather than of cause and effect.

On the other hand, in the recent monograph on diabetes by Naunyn,[3] cases are adduced which indicate that both severe bodily injuries, and also such injuries as produce only nervous symptoms and are in themselves trifling, may lead to diabetes.

Still more common than diabetes after injury is the "alimentary glycosuria"—*i. e.*, the appearance of sugar in the urine shortly after the ingestion of 100 grams of glucose. This form of disorder, which indicates not diabetes, to be sure, but a "tendency" in that direction, is met with in various nervous affections, among them the "traumatic neuroses." Strauss (cited by Naunyn) found this result in 14 out of 39 cases.

[1] See Jottkowitz-Oppeln, *Monatssch. für Unfallheilkunde*, No. 10, 1897.
[2] *Deutsches Arch. für klin. Med.*, Bd. 54, H. 53, 1895.
[3] Nothnagel's *Specielle Pathologie u. Therapie*, p. 64, 1898.

The *skin* and its appendages are parts of the body that are especially prone to suffer from such defects in innervation.

R. H. Reed[1] reports a case in which a man of sixty-three, after a fright at a railroad accident, lost the nails on both hands and feet, together with the hair of the head and beard, their places being gradually taken by a new growth.

Kriege[2] gives examples of urticaria-like tendencies induced by accidents, and cites the experience of Oppenheim, Page, and others. Attacks of widespread *eczema* have also been reported several times. The following case is illustrative, the accident constituting, however, only a partial cause : The patient, a physician, was run away with while driving with his wife. The horse ran for three miles, then turned a sharp corner and overturned the buggy, the occupants, however, not being seriously injured. The patient was in bed three or four days, and a few days after getting up was attacked with almost universal eczema—the scalp, arms, axillæ, chest, and legs being involved—and with conjunctivitis. It is many years since the accident happened, and there has been no return of the trouble, except a slight attack one year later, in the same part of the same month in which the accident happened.

The morbid conditions cited are by no means the only ones belonging to this class;[3] and, in fact, if the effects of acute nervous shock and prolonged nervous strain, whether associated with accident or not, were taken into account as they should be, large numbers of striking cases would be found, representing widely different diseases. I cite but one more case illustrating a possible connection between pernicious anemia and nervous shock due to railroad accident.

The patient was a middle-aged man of intelligence and general cultivation. While travelling by night a collision occurred between his train and another. The berth in which he had been sleeping, and which he had just left, was demolished. His wife and daughter, who were lying in the berth below his own, escaped without material injury, but another lady of their party was instantly killed. The remainder of the night was spent by the survivors in a country railroad station, watching by the body of their friend. The patient passed through the severe strain without marked injury, but within a few months his strength began to fail and a typical pernicious anemia gradually developed itself.

The *second group* comprises myelitis, encephalitis, neuritis, tabes, general paresis, syringomyelia, premature senility, and many other affections of the nervous system, with gross structural lesions, for which the accident is only a partial cause. In this class also belong Graves's disease, true paralysis agitans, chorea, and epilepsy, as well as various other nervous affections to which the individual patient was predisposed, or which may have been already present but latent; also the typical psychoses, as confusional hallucinatory insanity, melancholia, mania.

The *third group* comprises hysteria, hysteroneurasthenia, and disordered mental states related thereto—in short, the usual forms of post-traumatic psychoneuroses.

It is open to question whether there is sufficient reason for separating groups 2 and 3, since, for example, hysteria, which is the most important member of the third group, is, after all, a typical psychoneurosis, and the cases due to accident, when once they become chronic, are often indistinguishable from cases of the same sort of other origin. Nevertheless, it is an important fact that the form of post-traumatic hysteria is much more deeply modified and stamped by

[1] *International Med. Magazine*, June, 1893.

[2] " Ueber vaso-motorische Störungen der Haut bei der traumatischen Neurose," *Arch. für Psychiatrie*, vol. xxii., 241.

[3] See, in connection with this group of cases, Stern, *Trauma als Krankheitsursache*, Wiesbaden, 1896.

the character and special circumstances of the accident than that of post-traumatic exophthalmic goiter or paralysis agitans. Therefore, the third group is the only one which needs close examination here, the simple fact of the occasional occurrence after accident of the members of the second group alone needing recognition.

Graves's disease, chorea, epilepsy, paralysis agitans, and kindred neuroses may originate in accidents; though probably in most cases a native predisposition exists.

In speaking of post-traumatic epilepsy I do not, of course, refer to that form in which the skull is fractured or injured, or the brain damaged by actual lesions. Apart from these cases, which will be considered elsewhere, it appears certain that epilepsy may, though rarely, originate even in sudden fright. A case of this kind is recorded among the annals of the Franco-Prussian War,[1] in which a soldier was seized with an epileptic attack when suddenly and unexpectedly confronted, while walking alone, by an armed opponent.

There is no doubt that many *inflammatory and degenerative diseases of the nervous system* may be due in part to accidents, even those of which the chief factor is psychical shock, though perhaps less often than where this is conjoined with physical violence, or where the latter occurs alone. The nature of this relationship has been sufficiently discussed under Etiology, and I give here merely a few striking examples.

Accident Followed by Myelitis of Gradual Onset.—The patient, a healthy man of fifty-seven, was thrown out of his buggy in an electric car collision in a city street, falling with some violence on the brick sidewalk, and striking against an adjoining wall. His knees were badly bruised, and for the first few days his legs felt numb and helpless. The use of his legs quickly improved, but a sense of "numbness" remained, being especially severe along the under side of the thighs. For two months after this he went about, but had difficulty in getting up stairs, still suffering from a soreness along the under surface of the thighs. A week before I saw him, which was about three months after the accident, he had been attacked by severe pain in the back, followed by a rapidly progressing paralysis of both legs and of the bladder, becoming complete at the end of three days. From this time the patient continued to grow worse, and the case rapidly developed into one of complete dorsal myelitis. After an illness of a year he died, and the autopsy fully confirmed the diagnosis.

Webber[2] describes a similar case, in which acute myelitis came on three months after an injury.

A number of cases could be cited to illustrate the rapidity with which *tabes* may develop after even slight accident, the effective element being sometimes the general nervous shock, sometimes a bodily jar or injury.[3]

In like manner it could be shown through cases observed by myself and by others that accidents may bring a contributive influence of great importance to the development of *general paresis, multiple neuritis, localized neuritis,* and analogous affections, though such instances are rare.

[1] *Erkrankungen des Nervensystems in den Deutschen Heeren; im Kriege gegen Frankreich,* 1870–1871.

[2] *Boston Med. and Surg. Jour.,* Nov. 5, 1896.

[3] I have seen a striking case of this sort, which has been reported by Morton Prince in an excellent review of "traumatism as a cause of locomotor ataxia" (*Jour. of Nervous and Mental Diseases,* Feb., 1895), to which the reader is referred. The recent work on *Accident and Injury,* by Bailey, likewise contains an admirable discussion of this and kindred topics.

In some of the cases of neuritis the injury is local. Thus, in a case of my own observation (not medico-legal) a prolonged attack of intense neuralgia of the shoulder-blade region was brought on by a powerful blow between the shoulders, inflicted without warning, with the fist of an assailant. In such cases it is customary to consider that the nerve has received some local injury; but this view is not, I think, well grounded. An affection of the nerve-centers must surely be invoked in explanation for some instances, and it would not be easy to frame a satisfactory theory for its production.

In other cases *multiple neuritis* develops under conditions which make it probable that the impairment of innervation due to the shock of the accident was a partial cause.

Many observations noted both by American and foreign neurologists show that even moderate injuries, such as at other times lead to no serious results, may cause these diffuse lesions of the central nervous system, and even lead to inflammatory affections, such as myelitis; while after severe injuries these results are proportionately more common.[1]

Even such accidents as a fall from a wagon may cause spinal injuries. In a case of my own the patient immediately felt weakness and paresthesia in the arms and to a less degree in the legs, followed by ataxic, sensory, and motor symptoms of slight degree.[2] In a series of cases recently reported, poliomyelitis or an affection of the same distribution and similar result followed injury.[3]

Of great interest are the cases in which a nervous affection previously present but latent becomes manifest, and develops in such a manner as to suggest that the accident was the real cause. It is a question whether this is not the controlling principle in the development of nearly all the post-traumatic neuroses, and also the degenerative affections, such as tabes. For even in the case of hysteria and neurasthenia the accident may be only an exciting cause, the real cause being a predisposition which every person has to a greater or less degree.

The following case illustrates this principle, and is of special interest from its medico-legal bearing:

A policeman, of fair health, though of neurasthenic temperament, plunged his hand, during a scuffle, through a pane of glass, injuring the tendons and nerves of the wrist, so that for a long time he suffered from severe pain in the hand. While debilitated from this cause his eyesight, which had previously been good, rapidly failed, and this was made the ground for a claim of increase of pension. The claim was at first disallowed, because it was maintained that the injury could not have induced the impairment of sight. An investigation by a skilled oculist showed, first, that the impairment of vision was not feigned; next, that it was due to a defect of the retina which must have existed since birth, but had not previously made itself felt. The claim was finally allowed.

No doubt, every person carries more or less strong tendencies to diseases of different sorts, which an accident may make effective.

[1] See Willard and Spiller, *N. Y. Med. Jour.*, March 6, 1897; Webber, *Boston Med. and Surg. Jour.*, Nov. 5, 1896; Obersteiner, *Wiener klin. Wochenschr.*, p. 694, 1896; Strümpler, *Münch. med. Abhandl.*, 1st Reihe, 1896; Schmaus, *Virchow's Arch.*, 1890; Sänger, *Monatsschr. für Unfallheilkunde*, No. 10, 1897; Bikeles, *Obersteiner's Arbeiten*, Heft 3, 1895; Michel, *Wiener klin. Wochenschr.*, No. 35, 1896; Stolper, *Monatsschr. für Unfallheilkunde*, No. 2, 1898.

[2] See also Stepp, "Beiträge zur Beurtheilung der nach Eisenbahnunfällen auftretendm Erkrankungen," *Münch. med. Wochenschr.*, Nos. 41 and 42, 1897.

[3] Erb, Dinkler, *Deutsche Zeit. für Nervenheilk.*, 1895, 1897; Fränke, *Monatsschr. für Unfallheilkunde*, No. 3, 1898.

Typical Mental Affections of the Class of Psychoses.—Well-marked and severe affections of this kind occur more often after prolonged nervous strains involving great anxiety, grief, and fatigue than after accidents.

The following 2 cases are the only very serious ones out of nearly 200 that have occurred in my practice :

A young woman became highly nervous and excitable after a railroad collision of moderate severity, in which she suffered no material bodily injury. In time she became worse, and was constantly haunted by hallucinations of railroad disaster. She kept at her work, however, as factory operative, off and on for a number of months, during which time she had a suit pending against the railroad. While still in this unbalanced state another accident occurred at the railroad station of the town in which she lived, and she went with others to visit the scene. A rapid increase in her symptoms ensued, and soon, in spite of favorable surroundings, she was plunged into a severe, typical, agitated, suicidal melancholia, for which she had to be taken to an asylum. In the end she recovered.

The other case is that of a man of fifty-five years, free from neurotic antecedents, and of skill and ability in his profession (machinist and inventor), though without much social training. His illness dated from a railroad collision ; but it was never quite clear what happened to him, as his own account was confused, and he did not like, or was not able, to discuss it. Apparently he received no bodily injury, except perhaps a blow upon the head, indicated by a slight bruise. He was able to change trains and get to his home, 40 miles distant, but when he reached there he was hysterical, excited, and confused. This state passed into nervous and physical collapse, with hysterical tremor, anesthesias, and pareses, and with a mental state suggesting acute hallucinatory insanity, with a hysterical tinge. After some months he improved and became physically stronger, but his mental power and balance remained feeble.

Less serious mental symptom-groups of the class indicated by the last case—*i. e.*, characterized by excitement, severe depression, temporary incoherence, recurrent nightmares, or even hallucinations, associated with hysterical symptoms and signs of various sorts—are not uncommon as temporary occurrences during the first stage of the post-traumatic psychoses of the usual type. For many such cases the designation *hysterical psychoses* seems appropriate, and even with some of the more serious cases the hysterical element is obviously present.

Third Group.—By far the greater number of cases of the post-traumatic nervous affections of this group belong either in the category of neurasthenia or in that of hysteria. It is uncertain which of these types is more common, because the differential diagnosis is not easy. Severe typical hysterias are not common, though not rare ; but if we include under the head of hysteria the cases exhibiting certain of the so-called hysterical stigmata, such as anesthesia, even if in other respects not characteristic, and also those in which the symptoms wear the garb of neurasthenic or mental affections complicated by hysteria, there are but few cases left that can be wholly excluded from this class. The hysterical symptoms, whatever their form, are the "suggested" and the removable symptoms, and it is therefore important for the expert to acquire the ability to recognize this remarkable psychosis and to study its varied phenomena. It must, nevertheless, be admitted that we do not yet know just how far it is justifiable to spread the hysterical mantle. It is, for example, difficult to classify the cases of the fourth group, even if characterized in part by hysterical signs. But the first requisite is to note their existence. Again, it is doubtful whether to include the "habit-" and "association-"psychoses and -neuroses with hysteria. They might better be called *hysteroid.*

The clinical marks of hysteria may be divided between the "parox-

ysmal" and the "interparoxysmal," the former being represented by
the periodical outbreaks, of which convulsions are the best known
example; the latter by the paralyses of sensation or motion, contract-
ures, arrests of specific functions, localized spasms, peculiar mental
changes, and symptom-groups resembling those met with in non-
hysterical diseases, such as hip disease, disseminated sclerosis, chorea,
paralysis agitans, etc.

Recent researches have carried the analysis of hysteria a step back-
ward, and have shown that analogy exists between its characteristics
and those of suggestion in the hypnotic state. In other words, the
paralytic defects in hysteria exist only for the patient's momentary
consciousness. Also, the various manifestations of misplaced nervous
energy, whether temporary, as in the case of convulsions, or constant,
as in that of persistent anesthesias and spasms, are due to the activity
of mental operations, to which the patient's consciousness is tempora-
rily blind. It is as if the patient was carrying out the impulses of a
dream side by side with those of his normal life.

In analyzing the phenomena of hysteria, it will be best to begin
with the *mental symptoms*, since a comprehension of the mental state
of the hysterical patient is essential for a correct estimate of his case.
It is even probable that many of the hysterical disorders of vegetative
life, as the gastro-intestinal, vesical, and nutritive affections, are the
expression of disordered mental states.

The hysterical mental state, as measured by the strictly psychical
symptoms, is usually characterized by lack of stability, breadth, con-
sistent force and initiative, and of ethical motives of higher types, all
of which features are likewise characteristic of childhood and childlike
races. The logical power may be clear within narrow limits, but is
governed by no fixed purpose, and takes but few data into account
in arriving at judgments. The emotional life is usually under poor
control.

In the post-traumatic cases we generally have to deal with persons
not of strongly neuropathic temperament, but with those who have been
previously well and are suddenly taken sick. Hence the hysterical
condition in their cases is often superficial, and dominated by the events
of the accident. The patient, brooding over the sudden change in his
state, becomes self-centered and hypochondriacal to a degree rarely
seen in constitutional hysteria. Again, such patients are likely to feel
the exhaustion, incompetence, and irritable weakness which come from
living under a strain, with nervous machinery which has been thrown
suddenly out of gear, and in this sense they are neurasthenic as well
as hysterical.

Another mental peculiarity of some hysterical patients is a sort of
indifference and unreasoning contentedness, or apathy, which is by no
means incompatible with a tendency to make hypochondriacal com-
plaints of various sorts and selfish demands for help and sympathy.
Such a case is the following:

A woman, past middle life, fell from the steps of a car and was temporarily dazed. She
was able with assistance to walk to her home, a short distance away, but then had a violent
hysterical convulsion, with opisthotonos, and intense pain in the neck and back. These
attacks recurred, and were followed by complete hysterical paraplegia. From being an

energetic and hard-working woman she fell into an apathetic self-centered condition, and accepted without apparent concern the devoted sacrifices of her niece, who gave up her occupation to attend her. I examined her for the last time about a year after the settlement of her claims, and two years after the accident, and found her condition substantially unchanged.

All forms of hysterical symptoms are liable to occur in post-traumatic cases, but only those of commonest occurrence will be here considered.

Hysterical Disorders of Sensibility.—Anesthesia, hyperesthesia, paresthesia affecting the general sensibility, the special senses, the viscera, and the muscles.

Anesthesia of the skin is present in almost every case: sometimes in
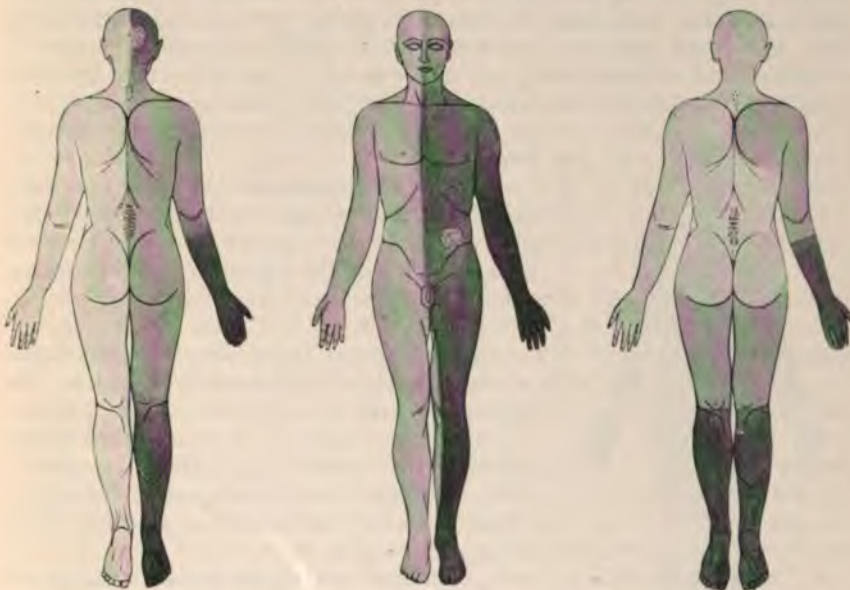
FIGS. 467–469.—Diagrams (based on personal observation) to illustrate the distribution of some of the more important sorts of disorders of sensibility. The darker shading represents the areas of anesthesias. These areas may be hemiplegic (sometimes passing a little the median line) or paraplegic, or both forms may be associated, and perhaps associated also with a slight general lowering of the cutaneous sensibility. The areas marked by crosses indicate hyperesthetic spots, such as are apt to occur spontaneously at various levels of the vertebral column, or to coincide with the seat of injuries, or to correspond to internal organs. The face and the head are usually less anesthetic than the extremities.

a high degree, so that it impresses itself on the patient's observation; sometimes so slightly that it is only discovered by careful tests, the patient being wholly unaware of its presence. In the former case rough tests, such as pricking or applications of the faradic wire-brush, may reveal its presence and distribution; in the latter it may be necessary to use pieces of hair or linen twine of variable length, and to compare carefully by prolonged examination the sensibility of symmetrically opposite areas.

This latter test gives information, it is true, only with regard to the sense of contact; while in hysteria the impairment of the sense of contact is not by any means necessarily a measure of the impairment of

the pain-sense, which latter may be lost while the sense of touch is retained. But it rarely, if ever, happens that the sense of contact is fully preserved when the pain-sense is greatly impaired, and under certain conditions the estimation of the impairment of the contact-sense is less open to error than that of the sense of pain.

Distribution of the Anesthesia of the Skin (Figs. 467–470).—In the commonest form, half the body is involved, the line of demarcation falling near to the middle line, but rarely exactly coinciding with it. The whole affected half of the body is rarely involved to the same degree. If one limb has received an injury, even if slight, the anesthesia is usually greater there, unless, indeed, the skin immediately adjacent to the injured point is hyperesthetic, as sometimes happens. The head and face, especially the latter, are less often strongly anesthetic than the limbs, and the chest is often but little affected.

Both halves of the body are rarely involved equally; but it is not uncommon to find both halves considerably affected, the acuteness of sensibility being everywhere relatively low.

Paraplegic anesthesia is seen in cases simulating dorsal myelitis; but these cases are rare, and generally indicate a severe form of hysterical defect, the impairment of sensibility usually being more or less general as well as in the legs.

Irregularity in the modes of distribution of the anesthesia is sometimes seen to the degree that it seems to occur in patches. The tendency, however, is for these to follow physiological rather than anatomical indications, at least to such an extent that the distribution in the sleeve-cuff or stocking form is sometimes seen.

Variability in the distribution and depth of anesthesia may occur, as shown in the transference of the symptom from one side of the body to the other, as in the celebrated magnet and metal experiments of the Salpêtrière. I have seen one case in which, without any discoverable cause, a spontaneous transfer of this kind took place.

It is noteworthy that slight traces of hemi-anesthesia are to be found by diligent search in conditions of nervous debility which would not ordinarily be classed as hysterical, such as cases of severe localized neuralgia of one side of the face, one arm, etc., as in amputation-neuralgia, even in men; and in cases which would generally be diagnosed as neurasthenic.[1] For this reason a doubt may exist whether it did not, in a given case, antedate the injury.

Anesthesia of the mucous membranes is more common than is usually

FIG. 470.—Diagram to indicate the relation between the two sides of the body as regards surface-temperature. If either side is anesthetic, it is usually cooler; but occasionally one limb or part of a limb is cooler, while the other of the same side is warmer, than its fellow. The coolest part of the limb is usually in the neighborhood of the joints.

[1] See Sänger, *loc. cit.*

realized, since it is not often carefully sought for. Some of the French writers (Sollier) regard this condition as the main cause of the sense of altered personality which is characteristic of some of these cases. The diminished sensibility of the stomach has to be assumed; but that of the bladder, vagina, urethra, and rectum can sometimes be inferred with great probability; and that of the nose, mouth, and pharynx can be found by direct observation. The absence of sneezing or signs of pain when the nostril is tickled on the same side with that of the cutaneous anesthesia is often a valuable sign in medico-legal cases, because it can hardly be simulated voluntarily.

The skin of the anesthetic half of the body is usually slightly cooler than that of the opposite side. Yet this combination is not constant, the condition of the vasomotor system being often most strongly characterized by its instability. Some patients complain mainly of hot, burning hands and feet, and this may be associated with an appearance of congestion and feeling of heat. Or the heat may alternate with an objective and subjective sense of coldness. Not infrequently the hand on the relatively anesthetic side is warmer than its opposite fellow, while the foot is at the same time cooler; or vice versâ. Such an alternating difference is sometimes seen between the two hands and the two arms. These differences in surface-temperature are best observed in the neighborhood of the joints (Fig. 470).

Anesthesia of the Special Senses.—The careful examination of a hysterical patient often reveals signs of this sort; but there are some of them which cannot be fully appreciated except by an observer trained not alone as a neurologist, but also as a psychologist. The more striking of those that can be discovered by every careful physician are the following:

Hysterical Deafness.—When one is talking with a hysterical patient, it is often noteworthy that he will turn one ear, and appear to strain to catch what is said, before any question has come up as to the acuity of his hearing. To a certain extent this is due to impairment of the power of attention rather than that of hearing; but a diminution of the hearing can generally be found when the cutaneous anesthesia is well marked and on the same side with it. The test with the watch will usually bring this out, the best method being to let the patient hear the ticking distinctly to begin with, so that he may know what to listen for, and then to approach the watch from a distance, over and over again, to the point of clear hearing, the patient's eyes being covered. Usually the hearing improves slightly by training; but sometimes, when the influence of fatigue comes on, it diminishes somewhat.

This test should always be corroborated by the tuning-fork test for bone-conduction, the best form of which is to let the patient hold the fork between his teeth or to place it on his forehead. A large fork of rather low pitch is the best. If the deafness, as shown by the watch, was due to middle-ear catarrh, the hearing by bone-conduction will usually be better for the worse ear, the vibrations coming through the bone being reflected back from the stiffened ossicula and tympanic membrane. Just the reverse is the case for hysterical or auditory nerve anesthesia, the ear which is the better for air-conduction being also the better for bone-conduction.

Anesthesia as Regards Vision.—This may be present in either of many forms: general amaurosis, concentric limitation of one or both fields, loss or modification of color-sense, rarely double vision. Another important form is characterized by apparently illogical limitations of the conditions under which vision is possible, as that of being able to see objects only at a certain distance, when they should be visible both nearer and farther as well, or that of not being able to see with one eye alone, though binocular stereoscopic tests prove that both eyes are really used, etc.

The tests for the *field of vision* should be made with a perimeter; but where it is simply a question of recognition of a distinct difference between the two eyes, a simple instrument will answer if the physician will take pains to accustom himself to its use (see under Differential Diagnosis). Fortunately, the most constant and most considerable *limitation of the field* is on the horizontal meridian, at the temporal side; and if the physician will conscientiously and thoroughly study the conditions present, even in this part of the field alone, he will obtain satisfactory results.

Closely related to the persistent concentric narrowing of the field is the *narrowing that takes place during the examination* (originally described by Förster under the name of the " shifting type "), either from fatigue or from some more subtle cause. During the past few years these two signs have been studied with the utmost care by certain German oculists and neurologists, and they deserve a high place among the post-traumatic hysterical stigmata. I cite a few of the conclusions arrived at by König,[1] after years of patient and laborious study of several thousand cases. The statements have reference, of course, only to hysterical patients:

" 1. The concentric contraction of the field of vision is a stigma of hysteria, having the same significance with the other disorders of sensibility met with in such cases, and is probably, like them, of psychical origin.

" 2. Even a slight contraction of the field, if constant, and not due to myopia or other optical defects, has the same significance as a considerable contraction.

" 3. In certain cases the concentric contraction of the field of vision may be the only discoverable sign of hysteria.

" 4. The contraction developed during examination is closely allied to the permanent form, and indeed probably represents a slight degree of the latter.

" 5. The contraction during examination is therefore to be regarded as a neuropathic sign.

" 6. The contraction during examination never occurs in any considerable degree with persons of healthy, normal nervous system. Slight degrees of it may indeed be found in such cases, but this is due partly to errors in observation, partly to failure of attention on the part of the patient. It is also to be remembered that the transition from health to disease is a gradual one, so that it is conceivable that this sign may be present in slight and temporary form, even in apparently healthy persons.

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[1] *Ueber Gesichtsfelds-ermüdung,* 1893: " Weitere Mittheilungen über die functionellen Gesichtsanomalien," etc., *Deutsche Zeitschrift für Nervenheilkunde,* vol. vii., 1895.

" 7. If the field of vision is found to be primarily of normal size for white and for colors, the contraction during examination is to be regarded as of significance only when it amounts to 5 or 10 degrees and is found to be present on repeated tests.

" 8. Contraction during examination and the permanent concentric contraction are, ordinarily speaking, to be regarded as objective symptoms. Their presence does not necessarily indicate a post-traumatic neurosis, but it does indicate a general neuropathic condition, though not necessarily a severe, persistent, or disabling one."

The *color-sense* likewise suffers in hysteria. The color-perception may be diminished throughout, or the normal color-fields may be changed in relation to each other, so that the red field may be larger than the blue; whereas in health the blue field is larger than the red.

A variety of other visual defects have likewise been noted. It would be impossible to give here a complete description of them all, but the important point to bear in mind is that if a hysterical patient makes statements which seem optically ridiculous, they are not necessarily evidences of fraud. Sometimes several images are seen with one eye; or a patient who claims to be unable to recognize test-objects which he must actually see, may find his power restored by being given a piece of paper with a hole in it through which to look.

Hyperesthesia and Paresthesia.—It is well known that hysterical patients sometimes develop an extraordinary acuity of sense, just as persons do in a hypnotic state. The pains and visceral sensations of hysterical patients may be classed in this category, and form a striking feature of the post-traumatic cases. This is especially true of the pain in the back, which may develop on the basis of slight strains, and may be associated with symptoms suggestive of Pott's disease. *Ovarian hyperesthesia* is common; also that of the *cardiac* or *gastric* area. The *eyes* are apt to be extremely sensitive to light, and slight use of them leads readily to congestion and pain. The *hyperesthesia of the skin* sometimes shows itself in the same areas in which anesthesia is usually seen. It is not uncommon to find the skin in the neighborhood of an injured part hyperesthetic, while the rest of the side is anesthetic.

Finally, hyperesthesia for cutaneous stimulations, such as light rubbing, may be conjoined with an anesthesia for impressions which would ordinarily be painful.

Paresthesia—that is, the feeling of prickling or numbness, or heat or coldness, or other abnormal sensation occurring independently of any immediate excitation—is very common. It is usually felt most strongly on the same side with the anesthesia or hyperesthesia, and may develop instantly after the accident.

Disturbances of Motion.—Hysterical convulsions of typical form are observable in post-traumatic hysteria as well as in hysterias of other origin. No special description of them need be here given, beyond the fact that they may come on almost immediately after an accident. The general rigidity occasionally occurring at such times is a phenomenon of the same order as the convulsions. The occurrence of convulsions marks a severe type of hysteria.

Paralysis.—Slight degrees of hysterical paralysis are common in post-traumatic cases, the affected part having usually received some

injury, generally trifling. Usually this paralysis amounts to nothing more than a mental inability to exert any considerable degree of strength. The patient seems to strain with all his force, and yet the result—the grasp of the hand, for example—is so ludicrously inadequate that he is often thought to be shamming.

More serious forms of paralysis are complete paraplegia, monoplegia, hemiplegia, or paralysis of the larynx. Usually, however, a skilled observer can develop enough power of voluntary motion to make the diagnosis comparatively easy; and where this is not true, it is generally noticeable that the paralysis is too complete for a genuine case of nerve-lesion. Thus, the paralyzed leg in hysteria, instead of preserving a certain amount of coarse movement at the hip-joint, is dragged along the ground or brought forward as if in one piece with the pelvis.

Hysterical ataxia, forming a sort of pseudotabes, occasionally occurs.

Hysterical tremor is of common occurrence, increasing under excitement and involving especially the paretic and anesthetic limbs.

Contracture occurs in hysteria after accident as well as in that due to other causes. The most striking forms that I have seen involved the muscles of the ankle, hip, and pelvis, in the latter case simulating hip disease, as will be indicated presently. In two ankle cases the contracture, at first associated with complete paralysis of voluntary motion, was so severe that the foot became cyanosed and cold, from obstruction of the circulation, attended with impairment of the local nutrition. The ankle in both cases had been sprained at the time of the injury. In the case of a small boy (not suing for damages), after a slight local injury, a contracture of the long flexors of the forearm came on, which kept the fingers closed tightly for a long period.

Special Forms of Hysteria Simulating Organic Disease.—It is unnecessary to describe all the special disorders to which hysteria may give rise in these cases, and it would be impossible to do so without giving a complete symptomatology of the disease. Some of the more important are the following:

Hysterical Hip Disease.—The closeness of resemblance between this affection and true tubercular disease is sometimes so great that a diagnosis can only be made by relying on the general features of the case. I give one striking example to illustrate this fact, and to emphasize a sign of importance to which but little reference has been made; namely, that as a result of the contractures of the trunk and pelvic muscles, the distance from the anterior superior spine to the malleolus or patella may be longer on the affected than on the unaffected side.

A woman, in consequence of a fall of slight severity, was attacked with typical hysterical symptoms, including hemianesthesia, and with a hysterical hip disease presenting practically all the signs of a true tubercular inflammation. Passive motion at the hip-joint caused exquisite pain, the leg was rotated inward, and the muscles of the thigh and leg became atrophied. The pelvis was tilted so that the affected hip-joint region became prominent, and the tissues about the trochanter seemed swelled and thickened. The patient was kept under close observation for three years, and during the first year, before her case was settled, she was carefully treated by skilful surgeons, by rest, extension, and apparatus. Early in the course of the case the actual lengthening was observed, though, from the tilting of the pelvis, attended with apparent shortening. The measurement increased until the excess over the unaffected side amounted to more than 1 inch. After a long time her general condition, which at first was poor, improved somewhat, and she walked about freely, though with a marked limp, the measurements, however, remaining the same. At the end of three years she was examined under full etherization, and both actual lengthening and apparent short-

ening were found to disappear. The hip was freely movable, and not the slightest roughness in the joint could be detected. As the effects of the ether passed off the former conditions returned.

Charcot[1] is said to have observed a case of this same sort; but I know of no others, except that R. W. Lovett has informed me that he also had seen the same lengthening in a case which he suspected to be of hysterical origin.

Paralysis Agitans and Disseminated Sclerosis.—The diseases which really deserve these names, especially the former, sometimes develop after injuries and shocks; and in view of their great seriousness, it is worthy of note that a few cases have been reported, indicating that the disorders of motion characteristic of them may be hysterical, and share in the relatively favorable prognosis of the other signs of hysteria.

Hysterical Affections Simulating Pott's Disease.—It has already been noted that injuries of the back, even when not in themselves serious, may form the starting-point for important neuroses and psychoses.

Nonne and Förster[2] have described such cases. Attention has recently been called to a striking complex, suggesting Pott's disease, of which the following case is a good example:

A mechanic, of good health and strength, was working at his bench, when a heavy beam fell from a scaffold 10 or 12 feet above the floor, and struck him on the head and shoulders, bending him over and partially stunning him. He was not paralyzed, and rode home on an engine, not particularly complaining of his back. During the day, however, pain in the back set in, and he became unable to move without great distress, and for the next year was almost confined to a chair, moving about a little on crutches, but unable to stoop to the floor. The knee-jerks became extremely exaggerated, and an ankle-clonus developed to such a degree that the room shook from the "trotting" of the leg as he sat in the chair. Nevertheless, at my examination, the fact that no real paralysis had developed, that the nutrition of the legs remained good, that characteristic abdominal pains were absent, together with the character of the impairment of sensibility of the skin (hemianesthesia of moderate degree), and the whole aspect of the case, convinced me that no real Pott's disease was present, an opinion which later developments have confirmed.

Although these cases bear the stamp of hysteria on the whole, yet their prognosis is relatively unfavorable.

Strains of the Back.—It is well known that strains of the ligaments and muscles of the back are extremely painful and disabling as well as rather chronic affections, and a very common result of railway injuries. In many cases, however, the unreasonably long continuance and exaggerated symptomatology of these disorders lead to the suspicion that they are of the nature of "habit-pains" or "association-neuroses," if not really deserving the name of hysterical, and that the best treatment for them is exercise rather than rest.

A gentleman, of unusual vigor and strong will, suffered a wrench of the back from the sudden shying of his horse. For about a year he suffered from backache, increased by movement, in spite of all my efforts and those of another skilful physician to relieve him. As summer came on I advised him, as a matter of last resort, to go into the woods as he had been formerly in the habit of doing, in the hope that he would at least secure the benefit of an enjoyable and hygienic life. In the following autumn I met him, and, on inquiring as to his health, he told me that he had not been more than a fortnight at camp before he was tramping with a 60-pound canoe upon his back, and that he had entirely recovered.

Post-traumatic Neurasthenia.—The general features of neurasthenia are so familiar as not to require prolonged discussion here; but it is important to note that the symptoms to which that name is attached

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[1] Cited by Berbez, *Hysteire et Traumatism*, 1887.   [2] *Neurol. Centralbl.*, 1896.

may apparently be really hysterical in nature, as has recently been pointed out by Morton Prince.[1]

Almost everyone who is affected at all by an accident feels himself for a time debilitated, irritable, timorous, unduly disturbed by noises and trifles of every sort, and incapable of exertion or resolution. In that sense the neurasthenic complex is extremely common. These symptoms may occur without being accompanied by any considerable hysterical stigmata, and yet the case may be of such a character, as regards mode of onset, behavior under treatment, and the temperament and social training of the patient, that the diagnosis of hysteria almost forces itself upon the mind. Nevertheless, it appears to be true that states which seem to deserve the name of true neurasthenia do follow accidents; and this is perhaps especially likely to happen with patients of the more cultivated and self-controlled social classes who are of neuropathic temperament.

It is doubtful whether the pathology of these post-traumatic cases is the same with that of the typical non-traumatic neurasthenia of adolescence and middle life; but so long as the nature of the latter affection is still unknown, we are not in a position to dogmatize on the former question. The important point is that in both the traumatic and the non-traumatic form many of the symptoms are superadded to an original defect, either by " suggestion " through the conditions of the accident or the foolish counsel of friends, physicians, or lawyers. These superadded symptoms are removable by a clear-sighted and conscientious mental education. In most cases the prognosis of the post-traumatic neurasthenia is relatively favorable, provided the case has not reached the " fourth period."

The following instance is in place :

A young lady, of excellent education and social training, but of neuropathic tendencies and not of vigorous constitution, was in a train which was suddenly precipitated into a deep ravine with a river at the bottom. She was completely dazed and deeply cut about the head, and was indeed discovered in a half-conscious state upon one of the stone piers of the bridge, at a considerable distance above the stream, without being able to tell how she had got there. For a long period she was in a highly neurasthenic state, incapable of any exertion, irritable, moody, depressed to the point of suicidal tendencies, and reduced in flesh, yet she did not show the usual stigmata of hysteria. A bad prognosis was given, partly from the character of the symptoms, which in a person of her slender physical vigor would, under ordinary conditions, have suggested a lifelong feebleness; partly because it was felt that with her social training the effects of the suit that was pending probably did not count for much as a depressing influence. After a year or so of rest, however, she became able to resume her former agreeable and engrossing occupation, though it was one which called for mental and physical endurance, and she soon recovered her full strength and spirits.

The neurasthenic complex, be its nature what it may, is, while it lasts, a cause of extreme distress, the more so because in many of the cases the patients retain an acute consciousness of their sufferings. Besides the general irritability and exhaustibility the patients usually suffer from poor and unrefreshing sleep, and are incapable of getting pleasure from reading because of the distress which the effort induces in the eyes and head. They are sensitive, emotional, subject to pains in the back, head, and sides, ringing in the ears, and scintillations of light in the eyes, incapable of engaging in social pleasures, and filled with forebodings. The weakness and exhaustibility may involve any or all

[1] *N. Y. Jour. of Nervous and Mental Disease*, 1898.

of their functions, including the sexual, in a high degree. If the cases become chronic, the acuteness of their sufferings may lessen and they may be able to attend to their business, but after this period is reached absolute recovery is rare.

Group Four ; Diseases of Exceptionally Serious Character and Obscure Causation.—Now and then cases are met with in which patients suffer from such serious forms of disease, tending apparently toward chronicity and degeneration, that the diagnosis of hysteria seems doubtful, and yet no localizing symptoms are present which indicate the existence of actual lesions of the nervous system. Perhaps in such cases we have to deal with an obscure degenerative psychoneurosis analogous to a severe form of paralysis agitans. In others, vascular degenerations are probably present (see above, under Etiology); while, again, in others we may have to deal with what might be termed a malignant form of premature senility.[1]

Perhaps the following case belongs in this category :

A man of sixty-two, with unusually good health, not alcoholic, and of regular habits, was knocked from his team into the street by an electric car. He was stunned and his head was cut, but after an hour or more he regained consciousness sufficiently to sit on the seat of his wagon and drive home, a part of the way with two men, but the last part by himself. He then picked up somewhat, but remained bewildered and unlike himself, and after the first six months grew worse. His nutrition failed without apparent cause, his limbs became cold, the muscles everywhere grew smaller and were the seat of fibrillary contractions. The mental condition was dull and childlike, though he could be roused to talk quite intelligently. The arteries of the arm at my examination were tortuous and somewhat sclerotic, and an examination of the urine showed a minute trace of albumin and a few hyaline casts. He walked with great feebleness, and in the year following his accident had scarcely been outside his door.

Impairment of General Nutrition.—An important consequence of accidents in some cases is a remarkable loss of flesh, with extreme prostration of the vital forces. Most of the cases in which this occurs would be, on other grounds, diagnosed as severe hysterias; and indeed it is well recognized that failure of general nutrition is an occasional feature of hysteria, no matter what its origin may have been. In some cases, however, this impairment of nutrition seems to occur independently of hysteria, either as an outcome of the primary shock or at a later period. In cases of the latter class care should be taken to ascertain whether the shock may not have led to some organic disease through impairment of innervation, as illustrated above (Class Two). The following case (not medico-legal) may belong in this category :

A man of seventy-one, but of remarkably good health and vigor of body and mind, and of excellent habits and strong character, was knocked down by a team, the pole of which struck him in the back. He was stunned, but was able to pick himself up for a time and to get home without assistance. He did not appear at first to have suffered severely, but never regained his full strength and elasticity. Two months later he was attacked, without appar-

[1] Crocq (*Nevroses traumatiques*), Dana (Hamilton's *System of Legal Medicine*), Nonne (*Neurol. Centralbl.*, 1897), and others have described such cases, some of which suggest a disseminated sclerosis. Quite recently Koppen (*Centralbl. für Nervenheilk. u. Psych.*, 1898, p. 85 ; *Jahresversamml. des Vereins Deutscher Aerzte*) has described a form of diffuse cerebral degeneration of the clinical type of *general paresis*, with widespread vascular lesions, which he believed to originate in vasomotor affections, such as Friedmann suggested as a cause for the arteriosclerosis that has been found in autopsies (see Sperling and Kronthal, *Neurol. Centralbl.*, 1889) after traumatic neuroses. Knapp (Dercum's *Text-Book of Nervous Diseases* by American authors) has reported similar cases; and the subject is well presented by Bailey (*Accident and Injury*, 1897).

ent cause, with severe sciatica, for which he went to bed. From this time—partly, no doubt, on account of pain—his nutrition steadily failed, and when I saw him eleven months after the accident he was extremely emaciated, and could not be induced to take or assimilate a sufficient quantity of food. The whole condition suggested an atrophy of the digestive tract. Shortly after my visit he died of pneumonia, which came on without obvious cause.

I have seen one case in which a woman who had previously given birth to healthy children became profoundly hysterical in consequence of a railroad accident; and about two years later, before the settlement of her legal claims, and while still in an extremely nervous state and having occasional convulsions, gave birth prematurely to a puny child, with a tendency to eclampsia.

PATHOLOGICAL ANATOMY.

The considerations falling under this head may be briefly summed up as follows:

A number of pathological changes, as degenerative spinal and cerebral scleroses, arteriosclerosis, and degenerative vascular conditions leading to diffuse hemorrhage, etc., have been found in the later stages of the traumatic neuroses and psychoses. These changes are, however, not in the least necessary for the production of the typical symptom-complex, and obviously occur only as occasional secondary results. No doubt they act now and then as eventual causes of impaired nutrition in the later stages of cases which do not go on to recovery.

It is an important theory that the arterial degenerations may be an effect of the disordered vasomotor tone which is so common in all the emotional neuroses.

The chronic degenerative changes of the nerve-elements are probably due to the combined action of a predisposing tendency, often accompanied with disorders of metabolism, as from syphilis and alcohol, reinforced by the depressing effects of the trauma.

The minute diffuse hemorrhages and necroses which undoubtedly occur occasionally as an immediate result of injury are probably not the direct cause of the typical symptoms, except in the sense that they may act as centers for excitation and inhibitory derangement of the functions of the central nervous system.

COURSE AND PROGNOSIS.

It is impossible to treat of the prognosis of the post-traumatic psychoses and neuroses as if we had to deal with a single definite affection, and yet it is desirable to avoid separating them unnecessarily. Certain classes may be excluded at once. The cases in which actual lesions are present, unattended by marked neurosal symptoms, have an outcome depending in each case on the character of the organic disease which is induced, and need not be further considered.

The serious cases of *Group Four* have a bad prognosis, but no general statement can be made respecting them.

The cases of *Groups One* and *Two*, comprising those in which the impairment of innervation due to the accident makes it possible for some other disease to obtain a foothold or to take on an accelerated progress, need not be discussed, since the prognosis varies with the particular affection in question. The claim is sometimes made, and with justice, that this same statement would apply to the cases of Group Three, comprising the hysterias and the hysteroneurasthenias and allied

forms of disease. Still, these affections depend much more on the nature and severity of the accident than do the others, and the differences as regards prognosis concern rather individual differences between cases than general differences between diseases.

The difficulties of accurately estimating the probable outcome of any given case of *traumatic hysteria* or *hysteroneurasthenia* are very great, especially if there be medico-legal complications. These difficulties are especially great at the period immediately following the accident, when the surgeon is first called upon to make a statement for the sake of adjusting claims and damages. The tendency is, in general, toward improvement and substantial or complete recovery; but the patient is often left, especially in the neurasthenic cases, with impaired nervous strength.

It is worth while to consider, as far as possible, the elements for the prognosis derivable from a consideration of age, sex, social status, race, previous record as regards health, and temperament, and presence or absence of medico-legal complications; as well as from the nature and duration of the case, the severity of the symptoms, and the influence of treatment.

Age.—The only period of life that involves an especially unfavorable prognosis is advanced years, severe shocks at that period often hastening the advent of senility. Conversely, the prognosis is relatively good for young persons: except in so far as that they are liable to such affections as epilepsy and chorea.

Sex.—The influence of sex is largely overshadowed by the influences related to the circumstances of the special case, but, on the whole, women are more likely than men to suffer ill effects from injury, and to recover less rapidly. This is due to the facts that their natural robustness is less, and that they are less likely to have strong interests, in the way of pleasures and occupations, to absorb their energies. Severe forms of hysteria are more common among women, and also the light forms of neurasthenia; but the severe neurasthenias are perhaps equally common among men.

Social Status.—I have several times stated that persons of good social training are less subject to the post-traumatic psychoses. When they do fall victims, however, it is generally because a predisposition of nutritional or neuropathic kind is present; and if this is the case, the outcome for complete recovery is relatively unfavorable, and relapses under the strains of life may be looked for. Furthermore, the financial circumstances of such persons often permit a sort of valetudinarianism which the sterner teaching of necessity might render impossible. Yet this rule is not a universal one, as is shown at hospital clinics by the occurrence of severe neurasthenia among males of the working age.

Race.—The marked tendency of the Hebrew races to suffer from nervous affections in general makes them, at least the poorer classes, severe sufferers from the effects of accident.

I have been greatly impressed with the temperamental sense of hopelessness among them, which defies all efforts at encouragement. I cannot, however, give statistics to show whether the number of cases of illness after accident, in proportion to the number of persons exposed, is actually greater than that found with other races.

Previous Health.—The presence of the alcoholic tendency may be considered as making the prognosis worse—other conditions being equal—both as regards the psychoses and the organic degenerative affections.

I have made no observations of importance bearing on this point beyond that confirming the universal experience as to the relation of alcoholism to non-traumatic insanity, but interesting data are recorded by Bailey.[1] The tendency of shock to hasten the progress of the degenerative affections in general makes the prognosis in cases of incipient diseases of these sorts materially more serious.

As regards the cases of the hysteroneurasthenic type strictly speaking, the influence of general ill health is somewhat analogous to that of the neuropathic temperament; that is, it need not necessarily exert a very bad effect unless it is of such a kind as to impair the elasticity of the spirits and the strength of the will. However, it very often does have this effect, and then a vicious circle is established.

Medico-legal Complications.—Fuller statistics on this point are greatly needed, but will not be forthcoming until experts are more ready than now to join in impartial attempts to discover the truth. Ostensibly, the best way to form a just opinion with regard to medico-legal cases would be to make careful studies of those free from legal complications.   But in reality this method is not altogether satisfactory. In the first place, the number of these cases is relatively small, especially in the direction of hysteria, for the reasons stated under Etiology. These are, in brief, that accidents occurring in sports, war, and dangerous occupations are rarely followed by traumatic psychoses, not altogether because there is nothing to be gained by going to law, although this factor certainly plays its part, but more because injuries occurring under these circumstances are in a measure anticipated and prepared for. Moreover, injuries thus received are not attended by any feeling of indignation against another person as being their cause. · Furthermore, the classes of persons whose circumstances oblige them to go to law also furnish the largest number of individuals likely to be affected by superstitious dread and panic, and consequently most likely to suffer from the post-traumatic psychoses. The law undoubtedly adds a new magnitude and terror to accidents, at least in the popular mind, and a new inducement to magnify and thus increase one's sufferings. Yet, in so far as this happens without the patient's conscious connivance, it would seem unjust to blame him for the added sickness that results, since, in fact, what is added is a tendency for which the patient is not necessarily accountable. The injurious influences attending litigation will gradually become less as the time approaches when physicians, lawyers, and the public learn to understand better these affections, so that they will lose something of the halo of mystery that now surrounds them. One good effect of this better understanding may be that the large verdicts which offer such a temptation to poor, ignorant, or designing persons will be less often awarded, and thus the likelihood of early settlements increased.

It is by an unfortunate sort of irony that the laws which were framed to work for the benefit of persons who have been injured through the

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[1] *Accident and Injury.*

fault of another, often work, in fact, to their disadvantage, by making it difficult for them to avail themselves of the precious opportunity afforded in the early stages of their illness for reasserting their self-control. If 'such persons could be assured that health would speedily return, provided they brought no suit, or if they should settle their claim at once for a moderate sum, they would often be glad to do so. But this assurance cannot be given, and so delay is advised. Meanwhile, the consciousness that a suit is pending makes it much harder for even the most conscientious person to adopt the mental attitude necessary for recovery so fully as to insure success, and very soon the invalid habits have tightened their grasp so strongly that no ordinary measures can relax them. Persons who are suffering from emotional accidents ought properly to be treated by physicians having special training for that purpose, and, if practicable, in suitable hospitals, or at least away from home. When the true nature of the disease becomes fully recognized, this need, which is already admitted as existing for cases of chronic hysteria of other origin, will be more generally acknowledged.

In general, it may be said that when a trial is concluded the patient ordinarily improves more rapidly; but this is not equally true of all symptoms.

Hysterical paralyses, which often count for much in court, are far more likely to pass quickly away than the impairment of mental balance and nervous strength; and thus the lawyer and prejudiced physician unjustly count many patients as simulants because they soon leave off their crutches, when, in fact, they may still be far from well.

Admitting that the influences which cluster round the patient's efforts to obtain redress through the law help materially to intensify and prolong the illness, it is quite another matter to infer that the termination of the suit will open the door to recovery. This may happen or it may not, and the only way by which the expert will be able to foretell which result may be expected is by learning, through experience and prolonged study of the case, how profoundly the disease has taken root, and how effectively the patient's temperament, will, and surrounding influences are likely to work in his favor. The light cases usually do well after trial, the bad ones usually do not; but the expert must learn to tell from something more than superficial appearance and violence of symptoms which cases are really light, which really bad. Sometimes this is impossible.

I have 2 cases in mind of the favorable sort:

One is that of a middle-aged woman, who had been a child's nurse and had led a pleasant life amid agreeable surroundings. After a long illness following an accident of very moderate severity, marked by serious prostration and hysterical symptoms of abdominal character, which had been the torment of her physician, she got promptly well, almost immediately after the conclusion of her suit, by putting herself, by the advice of a neighbor, under the care of a female hydropathist, who used an energetic water treatment, which during the unfavorable period of her illness the patient would never have endured.

The other case is that of a lady in late middle life, of an excitable and ardent temperament and deficient self-control, but of naturally robust health and great endurance, who became neurasthenic (probably the hysterical form of neurasthenia) after a trifling injury. She was forced to abandon most of her occupations, which had been many, and became hypochondriacal and depressed. After two years of this sort of life, her claim being settled at the end of the first year for a sum which did not fully pay her expenses, she went to Europe and (being a Roman Catholic) betook herself to Lourdes, where she had a brief

treatment. Through this means she lost her *delusion of illness*, though, as she afterward reported, she did not realize that she was cured until her return home, when she found that the slight influences that had previously affected her so unfavorably now had no such effect.

On the other hand, I will cite 2 other cases which may stand as types of a large number, in which the outcome was much less favorable than might have been anticipated.

A middle-aged woman, of excellent health and character, had a fall from her berth on a steamboat on account of the breaking of the support. She sustained bruises of moderate severity, and was found several years later to have a retroversion of the uterus, which may or may not have been due to the accident; but her real illness was a hysteria of typical and severe form. Her case was settled fairly early for a small sum, in the expectation on the part of her physicians that she would soon improve. This expectation was not realized, however, and she is still, at the end of four years, and in spite of thorough treatment, private and at a nervine hospital, a broken-down hysteroneurasthenic, though slowly gaining.

The other case is that of a man, who, at the time of his accident, ten years ago, was a spirited, vigorous, and trusted railroad employé of rather high grade. He was struck by a freight train and rolled over and over, breaking some of his ribs, but was, however, able to return to partial work in the course of a few weeks. He has indeed continued to work ever since, but under the drag-weight of constant and typical neurasthenic disabilities, which the best of his efforts, supplemented by all that I have been able to do in the way of encouragement and stimulation, have not shaken off. This case had no legal complications.

Perhaps the striking fact is that the tendency to the post-traumatic hysteroid, or neurasthenic, psychoses is greater in the medico-legal cases, rather than that the prognosis of the legal and the non-legal cases is so very different when once we have to deal with well-marked, especially the severe cases.

Nature, Duration, and Severity of the Case.—No very important conclusion can be drawn from the nature of the case—that is, whether it is of hysterical or neurasthenic character—as regards prognosis. The duration of the symptoms is of greater significance, since in the types under consideration the effects of *habit* and the tendency to the formation of "*association-neuroses*" are strongly marked. Nevertheless, although many of these patients become chronic hypochondriacs, yet the fact that the symptoms and the illness as a whole are often due to what may be called panic or delusion, or, at least, suggested fixed ideas, makes the chance of recovery, even in late stages, better than might be anticipated, provided—and only on this condition—that the patient can be given the benefit of a really thorough expert treatment.

The features that make the prospects unfavorable are, as regards temperament, lack of elasticity and natural tendency to depression. Intelligence on the one hand and docility on the other count as favorable influences. As regards the special clinical signs, the hysterical paralyses are less serious than hysterical convulsions. The sensory disorders, unless profound, are unimportant for prognosis. Deep-seated hysterical mental changes are unfavorable, and the same may be said of profound nutritional failure, although at the same time this is less important than the same signs would be in nutritional failure from progressive organic disease. It is probable that the presence of circulatory disorders—cardiac or vascular—whether due to a paretic condition of the vasomotor apparatus or to an acquired tendency to disorderly vasomotor action, constitutes an unfavorable influence of real importance.

True neurasthenia is an obstinate and tedious affection; the hysterical form of neurasthenia is less serious.

Influence of Treatment.—This is one of the most important influences in determining the course of the case. The diseases with which we are dealing are not self-limited; they may be checked early under favorable conditions or they may run on indefinitely. In many instances it is doubtless the influence of the family physician that determines the future of the case, and on him great responsibilities rest. It must also be admitted, however, that there are many cases (especially medico-legal cases) in which we feel inclined to say—no matter whether the stage of the disease be early or late—that treatment might conceivably bring about a rapid cure, and yet we cannot find the treatment by which this can be accomplished. The conditions are too unfavorable.

DIAGNOSIS.[1]

The physician, in approaching a case assumed to be one of the post-traumatic neuroses, is obliged to consider, first, whether the patient is simulating or is really ill; next, the type of the illness, if it exists; and further, to what extent it may be considered as superficial and under the domination of excitement and the events of the accident; or, on the other hand, due wholly or in part to actual lesions of the nervous system or to profound disorders of circulation and nutrition. On the other hand, it is his duty to determine how far it may be attributed to the action of previously existing neuropathic tendencies, or contributive degeneracies of other origin, or to other causes not connected with the accident. As regards the commoner types of disease (as hysteria, neurasthenia, the psychoses, the spinal scleroses, the cerebral and spinal degenerations of vascular origin; strain of the lumbar muscles, Pott's disease secondary to injury of the vertebræ, etc.), while the diagnosis in well-marked cases is easy, there are certain essential considerations to be borne in mind.

The chief of these are the following: It is important to distinguish between true neurasthenia and hysteroid neurasthenia, the former being a more severe affection than the latter. The psychoses may, on the same principle, have a hysteroid element in them. The spinal scleroses and pressure-myelitis may be simulated by hysteria or a hysteroid affection, though a judicial consideration of the whole case will generally make the diagnosis possible. Finally, it is important to note that hysteria may coexist with organic affections, so that the physician must be prepared to diagnose both conditions separately.

Complete simulation is admittedly rare, though it is met with from time to time. On the other hand, exaggeration is common, partly as a hypochondriacal manifestation, partly (in medico-legal cases) because the patient feels instinctively the need of pressing the merits of his case against an assumed unwillingness to recognize them. Thorough and repeated examinations and real expert tact and knowledge are the only safeguards against deception and overstatements, and rarely prove ineffectual. A good malingerer must needs be a skilful person, possessed of great power of attention and self-control. On the other hand, although it is true that the expert may be deceived by trusting too much to the statements of his patient, it is more common still to see the signs and

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[1] See also under Symptomatology.

symptoms of hysteria taken as indications of fraud. Even the expert physician may be deceived through lack of care and lack of study of all the circumstances, or even in spite of these precautions, by an exceptionally clever malingerer. It is amazing to one who is familiar with the intricacies of the hysteroneurasthenic complex to observe how readily the assumption is sometimes admitted that any given patient, no matter how grossly ignorant and unintelligent, or how obviously in a state of feebleness and lack of self-control, may have learned the difficult art of consistent deception. Experts who wilfully take this position, and let the rare exception stand for the reasonable probability, are likely to make the results of their examination serve the needs of their argument, and are not likely really to promote the cause and reputation of expert testimony.

It is important in examining a new patient to ascertain, as a guide to the judgment, all that can be learned from outsiders as to his reputation for veracity and mental balance, and as to his habits at present and in the past. This inquiry is often difficult, and consequently too often neglected. Valuable pieces of information as to the patient's physical condition can often be gained while the history of the case is being taken and the patient is off his guard. It is, in fact, better to make the physical diagnosis incidentally, as it were, and without questions, just as far as is possible. The presence and seat of tremor, of hysterical deafness of one ear, of hysterical paralyses, pareses, and contractures, differences between the pupils (noted with reference to the position of the window or other source of light), the size and shape of the pupils, the color of the skin, the changes of color during the examination, can all be noted in this way, to be verified later if necessary. Likewise, a fair notion of the patient's mental characteristics, as regards endurance or exhaustibility, intelligence, memory (to be tested not alone for the events connected with the accident and illness, but on indifferent matters), hysterical indifference, scope of interests, anxiety, excitability, power of sustained attention, and the like, can usually be gained in the course of an hour's conversation.

The prominent rational signs of the *neurasthenic complex* are weariness, irritability, and weakness (local or general), associated with head-pains at the occiput, vertex, or temples, or assuming the helmet-form; pains in the back, aching of the muscles, prickling and numbness in the limbs, flushing and coolness indicating vasomotor irritability. If the case is of the *hysterical type*, these symptoms may be present in whole or in part; and in addition there will be others indicating, as it were, the malignant activity of an inner demon. Such are explosions of pain, of vomiting, of local weakness, of paralysis of sensation or motion, loss of voice, loss of eyesight or hearing, dysuria, dysphagia, dysmenorrhea, and many kindred phenomena.

The rational signs of hysteria may perhaps be more easily simulated than the physical, and, therefore, in courts of law special attention is paid to the latter. The *pupils* in states of nervous weakness of either type are apt to be larger in moderate light; and if hemi-anesthesia, even of slight degree, is to be found, the corresponding pupil will be usually the larger. The limbs of the anesthetic side are usually *cooler* than those of the other, or one limb cooler and the other warmer, or both

warmer, the reaction probably varying in every case at different times. Slight differences of this sort are often made light of, and, in fact, they may, of course, be accidental; but, other things being equal, they may be of great importance as corroborative signs. It is unreasonable to assume that a great number of accidental signs, all pointing in the same direction, would be likely to be without significance as indicating a morbid state; *but, of course, it must be considered whether this morbid state could have antedated the injury*, especially in view of Sänger's observations on out-patients of the working class who had not been injured.

The *sensibility of the skin* and mucous membranes may vary in hysteria, as indicated under Symptomatology, and it need only be said here that it is best to rely as far as possible on the patient's movements and manner without asking questions, unless it is important for scientific or other purposes to ascertain the exact limits of a sensory change.

Hysterical tremor need not differ from the tremor of neurasthenia, but may assume the intention-type. It is usually more marked on the side of the anesthesia.

Hysterical paralysis is rarely so complete that a skilful examiner cannot provoke slight voluntary movements, generally of a jerky character, and the positions which the limb habitually assumes are usually not those of a flaccid paralysis.

It is irrational, and implies a disregard of the very nature of hysteria, to demand that the paralysis of this origin shall obey the laws of paralysis due to injury of the peripheral nerves, spinal cord, or brain. Here, also, slight alterations of sensibility are often of actually greater significance, as against malingering, than more prominent changes. It is more easily conceivable that a person should fraudulently claim not to feel at all than not to feel quite so well. If doubt exists as to whether analgesia is present, the point of a needle may be thrust, with care but without warning, under a nail. It need cause no surprise if a hyperesthetic area exists in the midst of an area of anesthesia or analgesia, or if the conditions vary somewhat from day to day. It is an open question whether the presence of a slight hemi-anesthesia, occurring, as it sometimes does, without other signs, is a sure mark of hysteria as distinguished from neurasthenia. On the other hand, hysterical paralysis, and still more hysterical contracture, are not infrequently associated with a greater or less degree of atrophy of the muscles.

Hysterical visual defects, as has been said, often contradict the laws of optics. The patient, by his own testimony, may fail to see objects which in fact he must see. The failure is then rather the expression of a subconscious agreement " not to notice." The concentric contraction of the field obeys, however, more definite rules, and the same is true of the contraction of the field coming on in the course of the examination. Unless the physician is willing to spend the time and patience requisite for a careful perimetric investigation of the whole field, it is best to give one's whole time and care to establishing with confidence the limits of the temporal part of the field on the horizontal meridian. For this purpose a regular perimeter is not absolutely necessary. A good-sized book, preferably black in color, will answer the purpose. It should be held in a horizontal position, so that the patient

sights along the shorter edge, at some dark object in the same line, but farther away. A few measurements made with paper folded so as to give parts of right angles will enable the observer to estimate with moderate accuracy the angular position of given points ; and even without that the two fields can be readily compared. Colored chalks or pencils will answer for test-objects. Care and patience cannot be dispensed with. If any doubt still exists as to simulation, the Wilbrandt test may be used, in which the patient is placed in a dark room and the test-object replaced by a phosphorescent disk or a small electric light. Normal eyes show at first, immediately after leaving a brightly lighted room, an impaired perception for this faint light—*i. e.*, a diminished field—but the full-sized field is regained in the course of ten or fifteen minutes. In hysterical cases the contracted field also regains, as a rule, its normal size, but only after one or several hours.

Hysterical deafness has been spoken of under Symptomatology and one test of the tuning-fork has been described. Another test, called Rinne's, consists in contrasting the power of hearing by bone-conduction through the mastoid with that by air-conduction. If a deafness ascertained by the watch or voice is due to catarrhal disease of the middle ear, the tuning-fork is heard relatively better on that side by connection through the mastoid. If the nerve is at fault, however, the fork will usually still be heard, if held in front of the ear, at a time when the conduction through the bone is no longer audible. Tests with high and low tones would be of great value in hysterical cases, but have not yet been much used by neurological experts.

Reflexes.—The *knee-jerk* in both hysterical and neurasthenic cases is generally exaggerated, though occasionally it is diminished. The *wrist-jerk* is sometimes, but much less often, increased; and the *ankle-clonus* is occasionally, though rarely, present. On the other hand, the superficial reflexes—the abdominal, the cremasteric, and the plantar—are usually diminished or lost in proportion as the cutaneous sensibility is impaired. In this contrast of reflexes we have an objective sign of great value.

The *pulse* is usually rapid, and is increased under excitement or painful impressions. In the celebrated Mannkoff test for real as contrasted with feigned sensitiveness to pressure, the increase in the pulse-rate is taken as the objective sign of pain, and in the hands of those who have studied it the sign is of value, though often unsatisfactory.

The *respiration* is apt to be quickened under the same conditions with the pulse. Prolonged attacks of quick breathing may occur.

Vasomotor signs consist in the fact that vascular spasm, or, on the other hand, persistent and considerable vascular dilatation after local irritation (*tâches cérébrales*, dermatography), are not uncommon.

Hysterical convulsions, when typical, are easily recognized and distinguishable from epileptic attacks. In other cases the distinguishing marks are by no means satisfactory, and careful study is the only guide. The statements that hysterical attacks do not occur at night, or when the patient is alone or is free from excitement, and that such patients do not hurt themselves and never wholly lose consciousness, are unconclusive, though there is some truth in them all.

TREATMENT.

The treatment of the disease of Groups One, Two, and Four—that is, the typical affections only indirectly due to the accident, whether involving the central and peripheral nervous system or other organs of the body—need not be discussed here, except so far as it is necessary to say that the nervous weakness, the apprehension, and the hypochondriacal delusional tendency are apt to be mixed in with the signs and symptoms proper to the special disease itself, whatever its nature, and should receive their appropriate treatment.

All that could be expected in a surgical treatise such as this is a statement of the best medical opinion with regard to the treatment of the functional nervous affections of hysterical or neurasthenic character as they occur after accident.

As regards Group Three, the fundamental consideration that should underlie the treatment at every step is that, as the causes of the condition are largely of mental nature, so should the treatment be.

It is needless to say that if, in the early days after an accident, severe shock-symptoms are present, they must be treated by absolute rest and cardiac and vasomotor stimulants; and so, also, if sprains of the back or other local injuries have occurred, they must receive their appropriate treatment. The question often early presents itself whether sedatives, such as the bromids, chloral, sulfonal, or opium, should be used to quiet restlessness and relieve pain. In fact, it is customary to give them; and if their use is strictly limited to the first few days, there is perhaps little to say against the practice, though I believe that easily digested food and a little stimulant sometimes serve a better turn. It is, however, certainly objectionable to continue them long, partly because they are cardiac depressants, partly because, if the patient sees his physician take the tone that he "cannot get on without" remedies of this class, he is more likely to think himself seriously ill than if he were encouraged to think anodynes and sedatives unnecessary. This introduces the view, which I believe to be a sound one, that it is the attending physician who is often in the position to make or mar the patient's future. If he can gain his confidence, and if he himself understands the situation, he can do much to ward off the surplus of real apprehensions, hypochondriacal delusions, and morbid habits of pain and weakness which tend so strongly to fasten their chains upon the patient's mental and nervous life, and to intensify the real unavoidable derangements due to the accident. Unfortunately, the physician must, especially in the medico-legal cases, educate not only the patient but the patient's family; and this is often a difficult task, the more so that nervous invalidism may have been previously unknown in the household. It would hardly be desirable to discuss the further treatment of chronic states of debility and neurasthenia and the psychoses which tax so severely the physician's ingenuity and skill. Suffice it to say that the treatment must be conducted on the same lines as that of ordinary hysterias, neurasthenias, and habit-neuroses—*i. e.*, by baths, stimulant tonics, and, above all, by encouragement and mental education, aided by such means as static electricity.

Hypnotism is occasionally necessary and useful, though less often

so than would be supposed. A few treatments in one case of my observation initiated much better habits of sleep, and was one of the starting-points of recovery.

Early settlement of legal claims is important for the patient's health ; but when the sum offered in damages is very small, the question of its acceptance becomes a grave one. Often the patient would settle if he could be fully assured that he would be soon restored to health ; and the physician cannot give this assurance unless he is convinced by experience that he can carry the case to a favorable issue. It would be well if it were oftener possible to have such cases treated in hospitals, as is becoming the custom in Germany.

CHAPTER XXXIII.

SURGERY AND SURGICAL OPERATIONS IN THE TROPICS.

ALTHOUGH the manipulations of surgery when practised in the tropics may not—in fact, do not—differ from those followed in temperate climates, the conditions under which surgical operations are conducted in the warmer regions of the world deserve study and consideration.

In no sense can it be said that there exists a department of surgery specially appertaining to the tropics, in as far as the mere manipulations obtain; but we do find that there are questions of climate, race, sanitation, and hospital equipment which affect both the surgeon and the patient as regards the operations themselves, the after-treatment, and the chances of recovery.

General surgery is a part of the daily work of the tropical practitioner; and he who would practise in the tropics must be prepared to undertake surgical work in all its branches. Surgical specialists are found only in our large cities; and in western Europe and northern America communication is so free that patients can easily obtain the advice and skill of surgical specialists. In most tropical districts the opposite conditions are met with. Few tropical cities boast of surgeons in the sense of their being specialists, and the distances are so great and the majority of natives so poor that they cannot afford to travel far, even if they would, to gain special advice and skilled treatment for their ailments. The practitioner in the tropics is placed on quite a different footing from his home-dwelling colleague. He may be, and very often is, far separated from any other qualified medical man. He has frequently to make his diagnosis, and to act upon it, without consultation with a fellow-practitioner; he has frequently to press into his service for the occasion one of his more courageous lay neighbors, be he European or native, to help at the operation itself; and in nine cases out of ten he has to entrust the after-treatment to the nursing capabilities of hospital coolies. These are the conditions, except in the larger cities, which the medical practitioner has to reckon with when he elects to undertake the practice of his profession in the "darker" regions of the world. It will be seen, therefore, that the young medical man proposing to practise in the tropics must qualify himself before proceeding thither in a more thorough manner than is required of those who dwell nearer the centers of medical knowledge, where help, advisatory or operative, is readily obtainable. The native does not seek the advice of "the foreign doctor" for medical ailments so often as he does for surgical operations. He cannot be made to appreciate, because he cannot see, the superiority of European medical science over the mummeries and cajoleries of his own "medicine man;" but with modern surgery it is different. The manipulations of surgery

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appeal more directly to his senses, and he is more ready to submit to treatment in a surgical than in a medical sense. In this article, therefore, although it is necessary to consider in detail a few surgical operations that appertain more especially to surgery in the tropics, it is the principles involved, more than the actual operations, that first deserve mention.

The term "tropical" requires limitation and explanation, for under this category are included the widely varying equatorial, the tropical, and the subtropical regions. Without entering into technical geographical particulars one may roughly outline the regions indicated.

The Equatorial Region.—The equatorial belt possesses well-defined characteristics unknown elsewhere. It includes roughly all the region within 12 degrees north and south from the equator, and is marked by a wonderful uniformity of temperature by day and night, as well as throughout the year. The greatest heat seldom exceeds 90° or 92° F., and rarely falls below 74° F. The maximum may be taken at 95° F., and the minimum at 68° F. The usual daily range is only 11° F.

This remarkable uniformity is brought about by several causes: First, the days and nights being pretty nearly equal in length throughout the year, there is no excess of night to cool the soil by radiation. The soil is thereby maintained at a high, equable temperature throughout the year, and at the depth of 5 feet the annual mean temperature of 80° F., for the most part, holds good. Second, the aqueous vapor in the atmosphere helps to maintain the high temperature; for although the degree of humidity is not greater than in England, the actual quantity is much more, averaging about five times as much. Third, the uniform high temperature is maintained by the large amount of heat liberated during the condensation of aqueous vapor in the form of rain and dew. The rainfall is excessive, averaging about 80 inches. The whole belt is practically a forest-girdle round the earth; and it is a region of almost perpetual calm. In the equatorial region we have, apparently, every condition requisite for the natural cultivation of disease-breeding bacteria, and the effect upon aseptic surgical wounds is baneful and direct. To sum up the conditions of climate in this region of the globe, it may be said that it is marked by an almost complete absence of climatic contrasts; air, soil, and water have a uniform temperature bordering on 80° F.; the day and night temperatures vary but a few degrees; and there is a complete absence of season.

The Tropical and Subtropical Region.—This area includes all between temperate and equatorial climes. It is marked by distinctly tropical summers, by the rainfall occurring during the hot weather, and by strongly marked seasons. The summers are not hotter than in the north, but they last for at least eight months, and are much moister. The winters are cool, dry, and bracing. The rainfall varies from nil in rainless regions to as much as 160 inches. This is in marked contrast to the equatorial zone, where uniformity prevails. In the tropical region we have fiercer summer heat; cool winters; well-marked rainy seasons; periods of great humidity and parching drought; and prevalent storms, in the form of typhoons or cyclones, keep the air in constant motion.

But no account of thermometric, barometric, or hygroscopic deviations brings home to one the climate and conditions of life in any single part of the tropics. Within this region we find lofty snow-capped mountains and plateaus, alternating with deadly mangrove swamps, and the deltas of mighty rivers. Here we find a city built on a water-logged soil, and another on a precipitous hillside. Here a series of volcanic rocks take the ground, a granite formation crops up, or a loess bed is overlaid by the alluvium from some of the greatest of the world's waterways. With these variations health varies; and the effect of the climate upon the immigrant from temperate regions, as upon the native, is in direct proportion to the elevation, the soil, the natural drainage, the habiliments, and the dwellings met with in warm countries.

In several regions of the tropics an important factor in the cause of disease is the great difference between the night and the day temperatures. To the military surgeon, more especially during campaigns, this variation is a matter of primary moment. Men suffering from the shock of bullet or bayonet wounds, or from loss of blood, if left exposed at night, succumb quickly to the depressing effects of cold, or are carried off by fever, dysentery, or tetanus. Even in European countries, as witnessed during the Peninsular War, tetanus was a very common cause of death among wounded British soldiers when exposed to the cold of a Spanish night on high ground. In campaigns conducted in such climates as the Soudan, where the soil is sandy and the heat intense during the day, one finds the depressing effects and fatal consequences of this extreme variation between day and night temperatures most marked. A little consideration of the subject will explain how this comes about. Since sand is a bad conductor, the heat produced by the sun's rays is conveyed downward into the soil with extreme slowness, and must necessarily remain longer on the surface—in other words, the temperature on the surface of the sand is abnormally high. At night the cooling effects of terrestrial radiation being greatest on bare and porous surfaces, the climate of sandy deserts is characterized by nights of comparatively great cold. These alternations of heat and cold are still further intensified by the great dryness of the air over extensive tracts of sand.

The study of climate and its effects upon the individual in health and disease is too wide a subject to be dealt with here; but the brief outlines given will suffice to show the variable nature of the meteorology of the regions styled "tropical," and help to elucidate the surroundings in which the surgeon has to work who practises his profession in the tropics.

Instruments.—It is not the quantity, but the quality, of surgical instruments that has to be specially cared for. Instruments should be obtained from the very best makers, and should be of the most reliable materials. Cutting-instruments and saws will retain their edges well-nigh in direct proportion to the quality of their steel; and the length of time they remain sharp is an important point for the surgeon in an isolated or distant colony. Instruments with any degree of mechanism in their construction are apt to give rise to trouble unless carefully selected. *Lithotrites* are frequently a source of trouble. Instruments,

moreover, have to be carefully attended to, otherwise rust will speedily destroy them. A coating of vaselin will serve to preserve them. The boxes in which they are kept should be stripped of their velvet show-linings, and nothing but wood or, better still, metal cases used. Instrument-makers exhibit neatly made metal boxes, with tightly fitting lids, and not infrequently try to persuade purchasers that no damp can penetrate them. This, as every medical man knows who understands what tropical heat and moisture mean, is a delusion. Nothing will keep out the damp in a tropical climate unless the metal box be soldered. Therefore it is wise to insist that all instruments of a metallic nature sent out to the tropics should be enclosed in tin cases, and the lid of the casing soldered. Another important factor is to ensure that the instruments, before being put in, and the box itself, be thoroughly dry. They should not merely be wiped dry, but they ought to be exposed to a high temperature before the box is closed and soldered.

Hypodermic syringes are a constant source of annoyance. The best for tropical use are made wholly of metal—barrel and piston. Vulcanite soon gives away, and the leather piston of the ordinary syringe quickly perishes. The needles ought to be of platino-iridium; this material does not corrode, as steel needles do, and it is harder than the gold needle so commonly advised. The wire used to keep the tube of the needle open should also be of the same metal, and it is wise, even then, to cover it with vaselin before passing it through the needle previous to its being put away.

The *hernial truss* in common use in temperate climates is unsuited to tropical requirements. The leather with which it is lined gets soaked through with perspiration, not occasionally, but well-nigh constantly. It speedily wears out and quickly smells foul. The truss should be of a material impervious to water; the celluloid or enamelled truss—the bath truss, as it is termed in England—is the only kind that should be recommended for wear in warm countries.

India-rubber fittings and tubes suffer in the moist heat of the tropics to a woful extent. The India-rubber parts of the aspirator used in the operation of lithotrity are a constant source of anxiety, as, do what one will, the material gets cracked and fissured. Examples might be multiplied, and with advantage; but the thoughtful surgeon will be warned, it is hoped, by these few remarks, to be specially careful in the selection and in the preservation of instruments intended for use in warm climates.

The Class of Surgical Cases Met with in Tropical Practice. —It may be said that there can be no difference between the kind of surgical ailments to be treated in temperate and in tropical regions. This is no doubt true in the abstract; but there are local circumstances at work which considerably affect the numbers of any particular disease or injury. One of the most prominent differences consists in the number of accidents met with. In many parts of the tropics street accidents are reduced to a minimum, as in China, where vehicular traffic is almost unknown; but in the large cities of India, where great commercial industry prevails, we know that the opposite obtains. Factories are rare, and mining pursuits few and far between. Railways are " conspicuous by their absence;" therefore it comes about

that the majority of injuries dependent for their cause on modern machinery or means of locomotion are well-nigh removed from the list of surgical work.

Tubercular diseases in children, so fruitful a source of surgical work in Europe, are much less often met with. The majority of cases presenting themselves for operation are of the nature of tumors, vesical calculi, deformities such as harelip and cleft-palate, scrotal tumors of the nature of elephantiasis, eye-affections, and ovarian disease. Hernia would appear to vary in the extent of occurrence according to race. It might be expected that in countries where the inhabitants were accustomed to carry their burdens on their backs, instead of by vehicles or on horseback, hernia would be a common ailment. This, however, is not the rule. In China, for instance, hernia would seem to be a rare occurrence, while in India it is fairly prevalent.

In the course of nine years, during which the writer was attached to a large Chinese hospital, only 1 case of strangulated hernia came under his care. Manson, who resided in different parts of China for twenty-two years, had occasion to operate twice only for the same condition during that period. In India, on the other hand, where a wheeled carriage is more used, Brig.-Surg. Lt.-Col. Kenneth MacLeod performed herniotomy 47 times in ten years, and operated for radical cure of hernia 107 times during the same period. It would seem, therefore, either that hernia is not associated with manual labor so frequently as we are taught to believe, or that the parts concerned in hernia have, by a developmental exigency, become so strengthened amongst the Chinese as to be able to withstand the pressure on the inguinal region induced by strain.

The reluctance of the native in the tropics to submit to "foreign" treatment is a direct factor in the results of surgical operations. Few natives of the tropics come to the European surgeon for treatment until their diseases have advanced so far that relief or cure is well-nigh impossible. They have, in the majority of instances, gone through a course of medicinal treatment by native "medicine men," whereby precious time is lost, and frequently harm of a permanent character has ensued. A calculus is allowed to attain gigantic proportions; an ovarian tumor grows to elephantine dimensions; a scrotal tumor may weigh 50 to 100 or more pounds; fractured limbs threaten mortification; and strangulated herniæ are allowed to become gangrenous before the European surgeon sees the patient.

It is the exception to have to treat a case of tumor, whether simple or malignant, in the early stages; in fact, the surgery is for the most part desperate, and the practitioner in the tropics is thus placed at a distinct disadvantage when compared with his home-dwelling confrère.

A further consequence of this inherent tendency of the native to delay submitting himself to the knife is that surgery as a whole suffers thereby in the eyes of the natives. Success is the chief recommendation for surgical interference in the opinion of all mankind, but more especially is this the case with the colored races. Unless a cure can be guaranteed, the native is unwilling to submit to operative procedure.

In comparing statistics, therefore, anent the relative success of surgical operations in temperate and in tropical climates, the desperate nature of the surgery in the case of tropical countries has to be considered and allowed for.

In his clinical and pathological observations in India, Sir Joseph Fayrer writes: "As a rule, I think it may be said that simple fractures are almost as easily repaired in Bengal as in Europe; and that, considering the depressing influence of a malarious climate, a poor

and mainly farinaceous diet, a more or less general prevalence of anemia and splenic cachexia, the results of treatment are satisfactory." With regard to compound fractures, pyemia plays as fatal a part in India as elsewhere.

Anesthetics.—The subject of anesthetics in the tropics is one fraught with deep practical interest. In the first place, it must be remembered that professional anesthetists are well-nigh unknown in any tropical city or country. The administrator is usually a brother practitioner, or it may be that he is merely a lay European assistant or native. In out-of-the-way districts the surgeon is often single-handed; he has to commence giving the anesthetic, and when the patient is under the influence the administration is handed over to whoever is available. It is evident, therefore, that the apparatus to be used must be of the simplest nature. Placed at a disadvantage seemingly so great, one would expect to hear of many "accidents" during the administration. This, however, is not the case; there are fewer untoward results reported from the tropics than is the case at home. The writer has seen and known of chloroform being administered in thousands of cases in the East with no deaths, and but seldom have any serious symptoms ensued. Chloroform is the anesthetic most in favor in the tropics. An operating-theatre in a tropical country is in a very different state, as regards the free circulation of air, to what we find in more temperate climates. The necessities of the climate require that the windows shall be open, and that air be allowed to enter freely. Operations are conducted with open windows, and it may be open doors, or under the wave of the punkah. A concentration of chloroform vapor under these circumstances is well-nigh an impossibility, and the consequence is that an "overdose" of chloroform is almost unheard of. The apparatus is usually a towel or a simple frame upon which a layer of lint is spread, and by using the drop-bottle there is little danger of an overdose.

Anemia.—*Europeans.*—The one physical condition directly attributable to prolonged residence in the tropics, and from which there seems no escape, is a deterioration of the blood and a consequent anemia. This state is the outcome of living in an atmosphere of high temperature, and is accelerated by malarial attacks, having for sequelæ congested liver and intestinal or splenic derangements. The anemia may vary between a minor degree and a strongly marked type, complicated with hepatic and splenic enlargement. When a healthy individual of adult age first visits the tropics the heat serves as a stimulant, and he can and does enjoy exercise which in a few years it is impossible to take without incurring lassitude and exhaustion. Many things conduce to this: the climate in time causes the European in the tropics to yield to the depressing effects of continued high temperature. The vitality is lowered; sleep becomes gradually more uncertain and precarious; appetite is first capricious and then fails. All these tend to lessened muscular activity and power, to increased weariness of body and irritability of mind.

The rarefaction of air dependent on great heat renders the amount of oxygen available in a given quantity of air less than in temperate climates. The blood thereby suffers, the corpuscles diminish in number, and, in consequence, fat accumulates in the tissues of the body

and in the blood-corpuscles themselves. The constant state of perspiration leaves less chance of the kidneys being well flushed, and the liver becomes engorged with blood. It is not alone excess in eating and drinking, as is generally supposed, that determines hepatic congestion. The climate *per se* is the initial cause of visceral failing, and renders the European liable to malaria or to any abdominal ailment, such as diarrhea and dysentery. This habit of body is but little conducive to high recuperative power, and with this condition the surgeon has to cope and to calculate when any major operation is contemplated. Most surgeons in the tropics prefer that Europeans with surgical maladies that do not require immediate treatment should proceed to more temperate climates before being submitted to operation. This is not caused by any feeling of inferior skill on their part, but by a conscientious belief that such a proceeding is for the patient's good. It is insisted upon from the fact that an atmosphere more native, and therefore more health-giving, is required than can be met with in the tropics, be the surroundings ever so sanitary.

Natives.—The effect of operations upon natives varies with the class, status, and caste of the patient. It is stated that the majority of the native population of most tropical countries are always on the verge of starvation. This may be true, and yet, except during actual famine, the native may be fairly well nourished. Nature is more liberal to the tropical dweller than to the more northerly resident. The heat of the sun is so abundantly bestowed that it provides warmth for the body and the household without the expense of fuel, and any but a minimum of raiment. Less actual food is required by the tropical than by the European laborer, and the kind of food upon which he thrives is of a relatively cheaper form. In India caste prejudices condemn the Hindoo to a farinaceous diet, and most natives can afford but little else, even should religious rites allow of it. In illness and in times of famine no good Hindoo would eat flesh, even to save his life. The European surgeon, accustomed to administer beef-tea and strong soups, milk, and stimulants when recuperative powers flag, must be content to see his patient slipping through his fingers, without being able to support the strength by rational methods.

In China a very different state of national feeling exists. The Chinese have no prohibitions as regards food or drink. It is commonly believed that the Chinese live on rice; but this is a popular error. The poorest coolie in China serving a contractor expects his employer to give him vegetables and either fish or pork with his two chief meals daily. But the diet for all that is meager, and it will be seen that the requisite metabolism of the tropical native is less than is the case with dwellers in colder climates; and that the condition thereby induced implies a lower physical resistance. The difference between the dwellers in a tropical and one in a temperate climate is best summed up in the word "stamina." The resignation of the native, when brought up for operation, is not allied to the fortitude of the Stoic nor the courage of the stout-hearted. His spirit goes, and his trembling limbs and quivering muscles reflect his mental state. With a patient in such a condition it can be easily imagined that it only wants a supervening shock to bring about heart-failure; and this is the surgeon's

chief dread when operating upon natives. If the native patient can be "got off" the operating-table alive, his chances of recovery are excellent. This is not the case with the average European; his better "stamina" enables him to bear the physical shock of a major operation; but his "tropical" habits as to mode of living are less calculated, during the stage of recovery, to be beneficial than are those of the more abstemious native.

The Opium-habit as it Affects Surgery.—Opium is largely consumed in China and the Malay Peninsula to allay pain. Smoking is the usual method of ingestion; but with the custom once induced, it is prone to lay hold on the individual, and to be continued as a habit when the reasons for its first being used have gone. Opium is extensively smoked by phthisical people, and so prevalent is phthisis among opium-smokers that no operation should be undertaken without first ascertaining the condition of the lungs. So effectually may the opium mask the attendant cough that it is only by physical signs that the condition is to be diagnosed. The opium-habit in phthisis does not *per se*, however, diminish the chances of recovery, as compared with non-smoking phthisical people; in fact, most medical men are agreed that the subjects of phthisis who smoke opium live longer than their more abstemious countrymen. Opium is also largely smoked by patients suffering from stone in the bladder. It is by them also taken to allay pain and irritation. No surgeon would hesitate, however, to operate upon a man for stone because he was an opium-smoker. Recovery is as probable with the opium-consumer as with the non-consumer. The writer's observations have led him to the conclusion that opium-smokers suffering from calculus seem to do better after lithotomy than after lithotrity, and this, too, when no discoverable visceral disease was found.

As regards opium-smoking, it may be safely summarized thus: no surgeon need hesitate operating upon an opium-smoker *because* of the habit. In other words, an opium-smoker with sound viscera has as good a chance of recovery as he who does not indulge in the practice. The smoker ought not to be deprived of his solace after the operation is over. To submit a patient to the double strain of a surgical operation and to the nervous irritability induced owing to suddenly stopping his opium is not a wise thing to do. It is mostly after severe operations on the lips, jaws, tongue, or trachea that smoking becomes an impossibility; and to opium-smokers so afflicted morphin ought to be administered hypodermically with no stinted hand. In head-injuries with insensibility deprivation of opium is not likely to prove detrimental, as the inhalation of the drug is more of a habit and a mental solace than a physical necessity.

Diabetes.—This disease is very prevalent among the better class of Asiatics. The persons most affected are those who take to "European" food and drink; and as it is this class of natives that come to the "foreign doctor" most frequently, it behooves the surgeon, before performing any operation, however slight, to assure himself as regards the existence of diabetes. It is well known that Jews in this and in other countries are very liable to diabetes; and, as has just been remarked, the disease is found among the more Europeanized

natives of tropical countries in much larger proportion than among those living on the diet to which they are accustomed, so it may be that in this fact we have a physical reminder that the Jews are an Oriental people, and that their metabolic powers have not, even after all these years, adapted themselves completely to European food and drink.

When natives take to what they call " European " food, they indulge themselves to an extent that is calculated to upset their economy. The " European " food is usually taken in addition to their own form of diet, whatever that may be, and all that is rich and highly nitrogenous in western food is selected. Wines also, especially sparkling wines, are regarded as an essential part of the ménu, and champagne, sweetened to suit Oriental palates, is freely imbibed. Gout, albuminuria, and diabetes are the necessary sequelæ of such a regime, and for surgical purposes the well-to-do native who " Europeanizes " his diet is perhaps the worst kind of surgical subject met with in tropical practice. The excess of starchy materials ingested by natives during their ordinary meals may be in accordance with climatic wants ; but with a diet that bulks largely in rice, the addition of meat and sweet champagne as extras proves impossible to metabolize.

Intestinal Worms.—Dwellers in the tropics are so commonly the hosts of intestinal parasites that it is well to pay attention to this subject before proceeding with any operation of expediency.

In " preparing " a patient for operation, be it a native or European, the surgeon should never lose sight of this possibility. The *round worm* is so common an inhabitant of the intestine in tropical countries that it ought to be regarded as a possible constant. Even if no previous symptom suggests the presence of worms, it is well not to rely on the history, but to administer santonin or other anthelmintic, as occasion requires, a few days before undertaking operations of expediency. With the altered regime entailed after an operation, such as rest in bed, alteration in diet, etc., the parasite, previously passive, may set up a train of symptoms, such as vomiting, colic, diarrhea, mucous and bloody stools, which are anything but conducive to the healing of wounds, or the rest that may be necessary to satisfactory progress.

Malaria.—All residents in the tropics are under the ban of malarial infection. In health the apparent immunity of some dwellers is proverbial ; but when any untoward condition arises, reducing the powers of resistance of the patient, " fever " is almost certain to show itself. European sojourners in the tropics may never develop fever until they return to the cold and damp of a temperate climate. A healthy woman, who never had an attack of fever, is liable to develop it after parturition ; the soldier who has escaped the disease in an Indian barracks, almost invariably develops fever when wounded in action. Occasions might be multiplied to show that " all tropical residents have malaria in them," and that when the vitality is lowered, either by climate or accident, the symptoms of its presence show themselves. In like manner surgical operations are liable to be followed by the evidences of malarial infection. Whatever lowers the vitality—be it such illnesses as typhoid or influenza ; accidents, such as gunshot injuries or fractures ; surgical

operations of a more or less severe nature—may "let loose" the poison.

With the threat of malarial fever impending after all surgical interference, the possibility of its development has to be considered and taken into account while a prognosis is being given or an operation contemplated. The previous history of the patient as regards "fever" has to be inquired into; the viscera have to be examined to ascertain whether or not they are affected by malaria; and it is a necessary step to search for the malarial parasite in the blood. Within the past few years the last-mentioned inquiry has very nearly attained the position of an exact science.

The mystery attaching to malarial infection is rapidly disappearing, and the development of fever at such seemingly untimely and unlooked-for occasions, as during the return to cooler climates, is in a fair way to be solved. Nature provides means of resisting disease and of eliminating septic and infective material in the case of many exposures in the category of possible ailments, and she has not neglected to do so in the case of malaria. In health, the phagocytes—the scavengers of the blood—maintain the balance in favor of the individual; but if for any reason their activity or power of work is in abeyance, the adventitious increment may obtain the upper hand. With active phagocytes a moderate degree of infection may be defied; but should the blood become deluged with poison, it can be easily imagined that their power may prove insufficient. On the other hand, should their power of "purifying" the blood be withheld, the same result may obtain. Perhaps we are likely to assign more to the phagocyte than its action would justify; but it is certain, by exact microscopic proof, that its power of attacking the Plasmodium malariæ is considerable. There may be other potent factors at work toward the same salutary end, but their powers have not received scientific proof. The writer has demonstrated on more than one occasion the marked connection between the presence and absence of phagocytes in freedom from, and attacks of, fever, respectively.

The most convincing elucidation of this phenomenon was in the case of a Japanese servant of the writer's. While investigating the subject of the plasmodium the blood of this man was frequently examined during a period of several months. While the man was in health phagocytes were numerous and active; but when his first attack of fever developed, the phagocytes almost completely, if not wholly, disappeared. As the fever subsided they again appeared, and with the restoration to health they were as active and numerous as before. This single case is sufficient to show the relation of the phagocyte to the Plasmodium malariæ and the so-called immunity from, or liability to contract, fever.

Within the last few months a great and important fact has been well-nigh proved, which will have a pronounced practical bearing. Ross, in Calcutta, has demonstrated that when the mosquito bites, not only does it imbibe the blood and the parasite into its stomach, but here the parasite undergoes development into a subsequent phase of its existence. Further, that the pigmented body characteristic of the malarial parasite becomes embedded in the tissues of the mosquito itself. But more important than all, Ross has proved, in birds at all events, that the bites of mosquitos charged with the malarial parasite can convey infection to healthy birds. This is perhaps one of the most important discoveries of the century, for it implies that malaria can be conveyed by the mosquito-bite. The practical bearing of this is at once apparent, and protection from mosquitos will become a greater factor in the daily life of tropical residents than even it has been formerly. Mosquitos have been dreaded on account of the local cutaneous affections they caused, but when it is appreciated that they, in addition, convey a deadly poison with their bite, their presence assumes a real danger.

Treatment.—The treatment of malaria may be summed up in the one word quinin. Quinin may be employed as a prophylactic or as a curative agent, but no other drug can be named that will equal in effectiveness this well-established remedy. The writer exhibited quinin in tropical practice after parturition with marked benefit, and before and after surgical operations, whether the patient gave a history of ague or not. In fact, quinin is the only means we can rely upon to avert or control the fevers of the tropics, let them arise spontaneously or after the surgeon has reduced the powers of resistance of the patient by surgical treatment.

Leprosy.—Surgical operations can be undertaken upon the leper with good hopes of success. In the later stages, of course, one is but seldom called upon to perform any operation, but skin wounds heal rapidly. The operations I have done are excision of nerves in the neck, subcutaneous division of contracted tendons in the hand, and subcutaneous division of palmar fascia. The parts healed without trouble; in fact, it was remarkable how speedily they closed. A ragged stump which caused great inconvenience to a leper induced me to perform a modified Hey's amputation of the foot. The parts healed very rapidly.

Beri-beri.—Patients in the acute stage of the moist variety of beri-beri do very badly if any surgical operation, however slight, is necessary.

Surgery in Warm and Temperate Climates Compared.— The results of surgical operations in the tropics as compared with those met with in temperate climates will be best shown by a comparative statement in the form of a tabulated schedule. It will be seen that the death-rate during the sixties, in the Medical College Hospital, Calcutta, is slightly higher than the mortality in London hospitals at about the same period.

While studying these results, however, it must be remembered that—

1. The patients in Calcutta were native Indians.

2. The normal death-rate of Calcutta is double the normal death-rate of London.

3. Calcutta is perhaps situated more disadvantageously than any other town in the tropics: *a.* Overcrowding is rife. *b.* Good drainage is well-nigh impossible, owing to the city being waterlogged, in consequence of its situation on low-lying ground. *c.* The natives are among the poorest and worst-fed of the inhabitants of India.

4. Hospitals in the sixties were old-fashioned; European nurses were almost unknown; native assistants had the handling of wounds and dressings.

5. A great deal of the surgery on natives is desperate surgery; the surgeon is called upon to act when disease has gained a firm hold of the patient, or when it is wellnigh hopeless to save life or effect a cure.

The difference in results, therefore, might be expected to be greater than we really find it.

The effects of modern surgical methods are well illustrated in the results of Surg.-Col. Kenneth MacLeod. But in addition to the introduction of Listerism, many hospitals in Calcutta have been rebuilt and remodelled; the European method of nursing has been followed; and the general sanitation of the city has been improved, thus accounting in India, as it has in Great Britain and America, for increasingly good results. Sanitary and Listerian epochs are nearly contemporaneous, and it is only since the Listerian period that the unsanitary state of hospitals has been dealt with. In fact, before the introduction of cleanliness the balance was perhaps in favor of the tropical rather than of the hospitals in temperate climates. The hospitals in the tropics, in common with all dwellings, are much more open to the air than in more northern latitudes. The exigencies of the climate render the free circulation of air a necessity, whereas up to two or three decades ago fresh air was rigidly excluded from European hospitals, and, more especially in cases of illness, from dwelling-houses also.

1848 Operations Performed by K. MacLeod in the Medical College Hospital, Calcutta, during the Years 1879–1883 and 1886–1890:

Description of operations.	Modified antiseptics (1879-1883).			Strict antiseptics (1886-1890).			Total of 10 years.		
	No.	D.	%	No.	D.	%	No.	D.	%
1. Eye-operations[1]	5	0	—	2	0	—	7	0	—
2. Operations on arteries . . .	5	0	—	6	0	—	11	0	—
3. Operations on veins	0	0	—	15	0	—	15	0	—
4. Operations on joints :									
Excisions	9	2	22.2	17	1	5.9	26	3	11.5
Others	32	2	6.2	51	0	—	73	2	2.8
Total joint-operations . . .	41	4	29.8	68	1	15.0	109	5	4.6
5. Operations on bones . . .	26	0	—	90	5	5.5	116	5	4.3
6. Amputations :									
A. For injury. 1. Primary[2] .	11	3	27.3	21	1	4.8	32	4	12.5
2. Secondary[2]	14	5	35.7	14	4	28.6	28[4]	9	32.1
B. For disease[2]	22	7	31.8	41	2	4.9	63	9	14.3
Total amputations (including fingers and toes) . . .	61	16	26.2	99	7	7.1	160	23	14.4
7. Removal of tumors :									
A. Malignant	49	13	26.5	87	9	10.3	136	22	16.2
B. Non-malignant. 1. Elephantiasis	140	26	18.6	117	4	3.4	257	30	11.7
2. Others	65	9	13.8	129	4	3.1	194	13	6.7
Total tumors	254	48	18.9	333	17	5.1	587	65	11.1
8. Removal of foreign bodies .	7	0	—	4	0	—	11	0	—
9. Removal of calculi :									
A. Urethral	3	0	—	3	0	—	6	0	—
B. Vesical. 1. By cutting .	19	3	15.8	12	0	—	31	3	9.7
2. By crushing	8	1	12.5	25	3	12.0	33	4	12.1
Total calculi	30	4	13.3	40	3	7.5	70	7	10.0
10. Incisions : Tracheotomy . .	17	7	41.2	13	5	38.5	30	12	40.0
Herniotomy . .	18	9	50.0	29	13	44.8	47[3]	18	46.8
For radical cure of hernia[3]	46	3	6.5	61	7	11.5	107	10	9.4
Laparotomy . .	1	1	100.0	5	4	80.0	6	5	83.3
Urethrotomy . .	29	5	17.2	70	16	22.8	99[3]	21	21.2
Others	178	17	9.6	151	7	4.6	329	24	7.3
Total incisions	289	42	14.5	329	52	15.3	618	94	15.2
11. Reparative operations . . .	61	3	4.9	36	0	—	97	3	3.1
12. Operations not classed . . .	21	1	4.8	26	0	—	47	1	2.1
Grand total	800	118	14.7	1048	85	8.1	1848	204	11.0

Pyemia as a Cause of Death.—Of the 305 deaths recorded by Bryant, 82 (26.88 per cent.) died of pyemia. Of the 102 deaths recorded by Fayrer, 68 (66.66 per cent.) died of pyemia.

From the above statements it would appear that the results of surgical operations in pre-Listerian days in Calcutta were pretty much in line with the results obtained in other countries.

In the Calcutta Hospital from 1879 to 1883 modified antiseptics were in force ; and from 1886 to 1890 a strict antiseptic regime was followed.

As a specimen of surgical work in an Indian hospital, a list of 1848 operations performed in the Medical College Hospital, Calcutta, by Surg.-Col. Kenneth MacLeod, is given above.

[1] There is a separate eye-hospital connected with the Medical College Hospital.
[2] Excluding fingers and toes.   [3] Admitted mostly in a septic condition.
[4] A great deal of this work tentative.

Comparative Statements of the Mortality after Amputations in Hospitals in Temperate and Tropical Climates :

	Cases.	Deaths.	Mortality (per cent.).	Recorder.
Crimean War (1854–1855)	1641	688	41.31	MacLeod.
French Army (1854–1860)	5037	3210	63.52	Legouest.
Calcutta (1859–1870)	227	102	45.13	Fayrer.
Newcastle-on-Tyne (1870 1874) .	. .	. .	48.31	F. Page.
Guy's Hospital (1861–1878) . . .	864	305	35.37	Bryant.
Calcutta (1879–1883)	61	16	26.22	Kenneth MacLeod.
Calcutta (1886–1890)	99	17	7.10	Kenneth MacLeod.
Newcastle-on-Tyne (1878–1883) .	.	. .	6.70	F. Page.

FILARIASIS.

By filariasis is meant an infection of the human body by a species of nematoid which, on account of its filiform appearance, is termed *filaria*.

In the year 1870, Lewis, of Calcutta, found a peculiar microscopical worm in the chylous urine of a patient suffering from elephantoid fever; and in 1872 the same observer found a similar parasite in the human blood.

The parasite was named the *Filaria sanguinis hominis*, as, when first found, it was believed to be the only filaria infesting human blood; but recently, in consequence of the investigations of Patrick Manson, the name has been still further specified.

The three best known varieties are :
1. Filaria sanguinis hominis nocturna.
2. Filaria sanguinis hominis diurna.
3. Filaria sanguinis hominis perstans.

Besides these well-known forms, Manson has drawn attention to three more blood-worms, which have been named :
4. Filaria Demarquaii.
5. Filaria Ozzardi.
6. Filaria Magalhesi.

The terms *diurna, nocturna,* and *perstans* refer to the habits of the parasite, the diurna being so named from the fact that it is found in the blood during the day only ; the nocturna variety is found in the blood during the night only, between the hours of 5 and 6 P. M. and 6 and 8 A. M. ; while the perstans, Demarquaii, and Ozzardi are to be found in the blood at all hours of the night and day.

With the exception of the variety nocturna, the pathological significance of none of these worms is of immediate importance to the surgeon. With this worm is associated what is known as elephantiasis and its sequelæ.

The Filaria Sanguinis Hominis Nocturna.—To obtain a specimen of this blood-worm, it is sufficient to draw the blood from the infected person after, say, 9 P. M. This is readily done as described in Vol. I., Chapter IV. A rapid microscopical examination of the field may bring into view one or several rapidly moving worm-like bodies. If the specimen is ringed with vaselin, the activity of the filaria may be watched for hours, or even days. As seen by a low power, the filaria appears as a colorless, transparent worm, rather blunt at one end, but tapering to the other. When examined more in detail and by a

higher power, say $\frac{1}{6}$, the animal is seen to possess a sheath, in which it lives and moves. After a few hours the rapidity of the movements lessens, when the anatomy of the worm can be more carefully investigated.

"Its average length is $\frac{1}{75}$ inch, its average breadth $\frac{1}{3500}$ inch, or about equal to the diameter of a red blood-corpuscle. It is enclosed in a transparent tubular sac, within which it can be seen alternately to contract and elongate itself. This sac is extremely delicate and translucent, and may sometimes, when the worm has shortened itself more than usual, be seen collapsed and folded like a ribbon, and the next moment be instantaneously straightened again by the extension of the filaria to its ordinary length. After death the worm may occupy either the entire length of the tubular sac or be so concentrated as to leave the tube empty at one or both ends" (Lewis).

The worm itself, according to Manson, consists of a column of closely packed cells enclosed in a transversely striated cylinder, and shows from before backward a head with a six-lipped aperture, from which occasionally a short fang of great delicacy protrudes and retracts. About one-fifth of the way along the body a shining patch, which Manson has named the V-patch, is to be seen. A little behind the middle of the animal, along its axis, a granular material, possibly a special organ, is to be made out, and between this body and the tail a second bright spot is evident, somewhat resembling the anterior. The function of these specialized parts is not known, but it is presumed that reproduction is their primary object.

This worm is only the immature young of parent parasites named, after the discoverer Bancroft, Filaria Bancrofti. The parents are much larger than the progeny, the female being, in length, some $3\frac{1}{2}$ inches, and in breadth, $\frac{1}{70}$ inch. The male worm is much narrower, being only $\frac{1}{140}$ inch in diameter. The discovery of the female led to an acquaintance with the sexual apparatus and the means of reproduction. In the uterus of the female, ova measuring $\frac{1}{880}$ inch by $\frac{1}{740}$ inch are to be seen ; and they can be detected in utero from almost their earliest conception to their more completed forms. The parent-forms have their habitat in the lymphatics, and as the embryos escape they get into the lymph-channels, and are carried onward through the glands and thoracic duct to the blood.

It is the immature worm thus developed that we find in the blood ; but being immature, how can the parasite provide for its continuance? The gap in the life-history was supplied by Manson. He believed and proved that the mosquito was the intermediary host in which the immature worm was developed. By long-continued observation and experiment he found that the visits of the mosquito to human beings fulfilled other ends than merely supplying food to this insect ; that, in fact, in the stomach and tissues of the mosquito the immature filaria, sucked in with the blood as the insect fed, develops and becomes metamorphosed so as to be capable of separate existence. When the mosquito dies the parasite worm escapes, and gaining access to the food, or more likely the drinking-water, is carried into the human stomach and again starts on its cycle of life. In view of Ross's observations in connection with malaria, it may be that the bite of the mosquito infects man. It has been shown, chiefly by Manson, that the presence of filaria in the blood is not necessarily followed by any sign, symptom, or pathological change ; that, in fact, in several parts of the world filariæ infest the blood of a large portion of the inhabitants without causing in the majority of instances any evident disturbance. This being the case, how comes it that the worm sets up disease in some instances only?

The filaria is a viviparous animal ; that is, the ova to be seen stocking its body do not escape as ova, but as mobile worms of the character described above. But if these worms are non-obstructive to the lymph-channels, what is the explanation of the train of symptoms that arise, commencing with lymphatic obstruction, dilatation, gland enlargement, and subsequent elephantiasis. The explanation is that for some reason, traumatic it may be, the parent worm aborts or delivers the ova into the lymphatic channels while they are still ova, and before they have attained the thread-like form in which they are normally born. It is evident that ova of the size specified would obstruct the lymphatics of the human body. The ova, expelled in a lump, as it were, just before breaking from their fetal coverings within the vaginal passage, are at their largest size, and, getting into the lymphatics, they act as emboli, block the lymph-channels, the glands, or even the thoracic duct, and cause distention of all lymphatic tracts distal to or beyond them.

Symptoms of Filarial Disease.—According to the group of lymphatics obstructed, so do we find variations of the evidence of the disease. Should the obstruction occur in the extremities, the foot or hand will in time become elephantoid ; should, on the other hand, the inguinal glands be the seat of trouble, what is called "varicose groin glands," or lymph-scrotum, will result ; when the channels around the bladder or kidney become impassable to the immature ova, chyluria supervenes ; or should the thoracic duct itself be blocked, then the whole area of lymphatics below may become varicose.

With the general statement of filariasis as given above, the details of the sequelæ will be readily understood.

Abscess.—Should a parent filaria die as it lies in the lymphatics of a limb, its remains may be absorbed; or, on the other hand, its presence may cause irritation and inflammation, resulting perhaps in an abscess. At times these burst spontaneously; but if the surgeon should incise them a parent filaria may be found.

The worm would, no doubt, be found more often than it is, were the surgeon alive to the possibility. Manson has drawn attention to the probability of internal abscesses forming in the thorax and abdomen. The writer, on examining the pus drawn from an abscess situated at the back of the liver (between the layers of the broad ligament), found in the specimen what seemed to be the sheaths of filarial parasites. At the time the writer was fully convinced that they were filarial sheaths, but, being then unacquainted with the possibility of their being filarial, he did not publish the statement.

Varicose Inguinal Glands.—In latitudes where the filarial worm is prevalent, one not infrequently meets with peculiar, soft, painless enlargements in one or both groins. The swellings may attain a large size without causing the patient much suffering or discomfort; and it is only when an attack of adenitis occurs that the condition is brought under the notice of the surgeon. Unless it occurs to the surgeon that the swelling may possibly be filarial, it is improbable that a correct diagnosis will be made. There are many evident causes that suggest themselves to account for the adenitis, such as penile or anal irritation, which can be readily eliminated. A case of filarial inguinal adenitis was mistaken by the writer for plague, the diagnosis being finally established by finding the parasite in the blood.

Lymph-scrotum.—Associated with varicose lymphatic trunks in the groin and thigh is the enlargement of the scrotum and the dilatation of the lymphatics upon its surface. At first the skin is soft and smooth and doughy; but as development proceeds the parts become denser and tougher with each succeeding inflammatory increment. The prepuce and penile coverings generally are likewise early affected, and the parts may in course of time grow to truly elephantine dimensions.

Hydrocele.—It is seldom that lymph-scrotum attains any size before a hydrocele develops with contents possessing the milky appearance of chyliferous fluid. But a true lymphoid hydrocele may develop independently of the superficial scrotal tissue being involved.

Chyluria.—With or without previous warning, the urine of a person living in a region where infection by filaria is possible is observed to be milky in appearance. Not the mere milkiness of phosphates, but the urine seems quite creamy, and its flow is at times interfered with, owing to clotting of the material. Should any previous symptoms obtain, they will be those of feverishness, backache, dragging pains in the loins and groins, and symptoms as if a renal calculus was passing.

The urine, known as "chylous," coagulates soon after passing, and speedily arranges itself into a fluid and a solid part. The solid part consists of a stringy, fibrinous coagulum, of a white or pink color, forming the main bulk of the discharge. Beneath this material the urinary salts deposit, and on the top and surrounding the coagulum the fluid has a

creamy appearance. The coagulum and deposit consist of intermingled epithelium, a few red and white blood-corpuscles, with a large element of a fatty material pervading the whole.   In the several parts of the fluid and coagulum filaria can usually be found by the microscope, and an albuminous precipitate is obtained by boiling.

Elephantoid Fever.—Accompanying all filarial diseases, fever sooner or later manifests itself. The attack has been named by Sir Joseph Fayrer "elephantoid fever." We are not aware that it occurs independently of local manifestations of an inflammatory nature, and it is these disturbances that specialize the attack. Lymphangitis and adenitis are invariable concomitants, and the result of the attack is associated with an increased area of tissue being implicated and added to the diseased part. The lymph-scrotum is increased in bulk, the extremity is further thickened, or the mass of the inguinal glands attains a larger size. The signs are those of lymphangitis and adenitis arising from other causes; there are local pain, swelling, and redness. The lymphatics may be mapped out as red streaks extending up the limb; or, if the attack is concentrated in the lumbar and abdominal glands, severe backache and testicular neuralgia are pronounced. In addition to the more common symptoms of "fever," vomiting and delirium are fairly constant. The onset is usually very sudden, the patient being struck down with severe rigors, generally of a prolonged nature. The high temperature may last for a few hours or a few days, and passes off with profuse sweating. Chyluria is evidence of the pelvic or abdominal lymphatics being implicated, and is a further aid in the diagnosis of the disease.

Treatment of Filarial Diseases.—Little is to be said in regard to the treatment of this insidious disease, whether as regards prophylaxis or remedial agents. Given a case in which filaria is found in the blood, we know of no drug that can reach the parasite, and thereby cure the disease.

Where removal to a non-filarial district is possible, the treatment ought to be tried at once. Short of removal, nothing can be done except to treat symptoms as they arise. However, the disease may spontaneously subside. The parent filaria may die, and with the disappearance of the worm from the blood the extension of the disease ceases, although the thickened tissues may remain. The writer used antipyrin, in 15-grain doses, at the onset of threatened attacks of filarial fever, with apparent advantage in a few cases.

Should an abscess form, it is to be opened. When lymphangitis or adenitis supervenes, it is to be treated as in cases with less specific cause. Local applications of heat or cold are agreeable and help to relieve pain; and should the temperature run high the usual remedies may be employed to control it. When the pain is attributable to adenitis dependent upon the density of the gland-capsule, it is expedient to divide the capsule subcutaneously.

Elephantiasis of the Extremities.—The lower extremities are much more liable to be attacked by elephantiasis than the upper. In advanced cases of the disease the bulk of the foot and leg is enormously increased, and they truly convey the idea of elephantoid enlargement. The first parts to show signs of deposit in the subdermal tissues are the foot and ankle. The dorsum of the foot especially

shows a thickening and enlargement of a hard, dense, incompressible tissue, giving the whole foot a lumpy appearance, the toes projecting as thickened stumps from the end of a misshapen mass. When attacks of fever supervene, the lymphatic tracts in the limb are red and swollen and painful, and the glands toward which they converge are enlarged and tender. As the inflammatory signs and symptoms abate, a hard, dense, thick cord may be felt along the course followed by the lymphatics of the limb, which assumes a dusky hue.

With each recurring attack the area of hypertrophy extends, until in course of time the whole lower limb is involved, and even the lower part of the abdominal wall becomes affected. At times vesicles form on the skin. These may burst, and from the openings a milky fluid may ooze, giving rise, when it dries, to crusts and scabs. Abscesses are not infrequently met with, which, when opened, have in some instances been found to contain a parent filarial worm.

Here, as in elephantiasis scroti, the disease may show itself in the form of a varicose condition of the lymphatics, giving rise to the terms *varix lymphaticus* and *nevoid elephantiasis*. These are but modifications of the more acute form of the disease, obstruction more than inflammation serving as the cause. On the lymphatics thus dilated tubercles and vesicles appear, varying in number from a few to hundreds. When these burst or discharge a coagulable lymph exudes, varying in appearance from straw color to red, and in quantity from a few ounces to a few pints in the twenty-four hours.

Associated with the elephantoid fever and hypertrophy of the lower limb, chylous urine is frequently present, showing that the lymphatic tracts of the ureter and bladder are simultaneously and similarly affected.

In time the limb becomes enormous, measuring, it may be, a couple of feet round the ankle. The muscles waste, the limb is an inconvenience, and the surgeon is consulted as to the possibility of removing it.

Treatment.—Short of removal, several therapeutic agents may be tried. Elevation of the limb reduces the size; firm bandaging helps to diminish the bulk; application of a rubber bandage does good as far as support and compression can; but all these are merely palliative; so also are leeching, blistering, and bloodletting. Ligature of the femoral artery has been tried, but the treatment seems misapplied, and Sir Joseph Fayrer, after having given it a trial, strongly condemns it.

The only thing left for the surgeon to do is to amputate, if the patient desires to be rid of the inconvenience caused by the bulky limb. There is no reason—leaving the ordinary dangers of amputation out of account—why the operation should not be undertaken with a view to alleviation, but the ensuring of a permanent cure will depend upon the position of the parent-worm in the system, and its vitality.

Elephantiasis Scroti.—The scrotum is a favorite seat of elephantiasis, and its lax tissue, dependent position, and rich lymphatic supply render the parts at times enormous. Commencing, perhaps, as a lymph-scrotum, or as an attack of lymphangitis, the result of blocking of the horizontal inguinal lymphatic system, the scrotum gradually increases in size. The thickness and coarseness of the skin render

it corrugated and fissured.   Lymph at times flows from the scrotum ; in some cases clear and serous-looking, in others thick and milky in appearance.   The subcutaneous tissues thicken, increasing the bulk and weight of the scrotum.   The tissues over the spermatic cord ·hypertrophy, causing the inguinal canals to dilate, so that not infrequently a hernial protrusion results, reaching, it may be, even to the scrotum.

FIG. 471.—Elephantiasis of the scrotum.   Weight 110 pounds.   Successfully removed.

Hydrocele of the tunica vaginalis is a frequent concomitant ; and cysts with fluid may occur along the spermatic cord.   The fluid contents are usually clear, but sometimes thick and milky, coagulating readily when drawn, and separating into a dense, fibrinous clot. Hydrocele may be an early notification of the existence of filaria ; and the surgeon, on tapping what seems an ordinary hydrocele, may find the milky fluid characteristic of filarial infection.

The inguinal glands at all times, even after one or two attacks of filarial fever, become matted and indefinite in outline, and after several recurrences remain permanently prominent. The scrotum becomes in time so bulky that the skin and lower part of the abdomen are dragged downward, so that the hair over the pubes seems as though it were growing from the upper part of the scrotum itself. The skin of the penis becomes hypertrophied to such dimensions that the penis appears deeply embedded, and the orifice through which the urine finds exit looks like a deeply sunk navel in the midst of a huge mass of hypertrophied tissue.

Treatment.—Removal of the scrotum is chiefly undertaken with the idea of ridding the patient of an inconvenient tumor that may assume such dimensions in bulk and weight as to preclude him not only from earning his livelihood but also from getting about. Tumors of great weight are recorded—several over 100 pounds (Fig. 471). Sir Joseph Fayrer removed one of greater weight than that of the patient himself after its removal. The writer removed one which turned the scale at 49 pounds after the blood and fluids had escaped from the tumor.

The curative effects of removal will totally depend upon whether or not the parent-worm is located in the lymphatics of the scrotum. If such good fortune should obtain, then removal of the scrotum is at once palliative and curative. Otherwise, however, amputation merely frees the patient from an inconvenient mass.

The dangers of the operation upon large tumors are: First, the immediate shock to the patient; and second, the primary hemorrhage. Where the organs are known to be amyloid, the heart fatty, and the patient in consequence much emaciated or weakened, operation can only hasten death. When, however, the patient is young and the organs fairly healthy, operation is in no way contra-indicated, as the hemorrhage may be controlled so as to render the quantity of blood lost inconsiderable.

Operation on a case of elephantiasis scroti of large dimensions is conducted as follows: The patient is prepared for operation in the usual way, both generally and locally. To empty the tumor of blood, it is necessary that the patient assume the recumbent position, and that the tumor be raised above the level of the body. In some cases it has been necessary to sling the tumor from the ceiling or from any fixed support across the bed or table. The elevated position also helps to reduce any hernial protrusion that may be present. The patient, before the tumor is elevated, should be placed on the operating-table and allowed to remain there, as if the tumor is permitted to become pendulous while he is being conveyed or carried from the ward to the operating-room, the blood, lymph, or hernia will return to the part.

While the patient is passing under the influence of an anesthetic, some surgeons recommend that the scrotum be examined, and a mark made by ink or colored pencil along the root of the tumor, so as to mark off the line where the diseased and healthy tissues meet, otherwise it may be difficult to follow the exact line after the parts are thrown into corrugations by the compressing elastic cord.

The patient, when completely anesthetized, is brought to the edge of the table in the lithotomy-position. A stout Esmarch cord is passed

round the root of the tumor, the center of the cord being opposite the center of the tumor below, the ends carried up over the pubes, crossed, and fixed behind the body in the lumbar region. To prevent the elastic cord slipping when the operation is commenced, strips of a roller bandage are looped over the tourniquet, one at each side of the perineum behind, and one at each side of the pubes in front. The ends of these bandage-slips are either tied in position or given to assistants to hold. Three skilled assistants are required: one to support the tumor, and two others—one on each side—ready with clip-forceps to seize bleeding vessels.

The antiseptic dressings are now removed and the operator takes his stand opposite the tumor. The first thing to be done is to free the penis and testicles. This is accomplished by passing a long grooved director down through the preputial orifice as far as possible. The point of the director is made to hug the upper wall of the channel, and when bottom is struck it is made to protrude on the dorsal aspect of the cutaneous covering of the penis. The point is cut down upon and made to protrude, and the skin is slit by passing a bistoury along the groove in the direction from the root toward the free edge of the prepuce. The glans will then be laid bare, when it is seized by the fingers, and the coverings dissected off until the penis is freed for some 4 or 5 inches. The penis is now wrapped in boric gauze and kept out of the way.

The next step is to dissect out the testicles and cord. This is done by making an incision from over the pubic spine on each side downward for a sufficient distance to expose the cord. The length of the cord in very large tumors is considerable, and the exact location of the testicle equivocal. When the cord is found, however, the tissues may freely be cut downward along it until the testicle is seen. The testicle and the cord are then freed from the surroundings, partly by cutting and partly by tearing the tissues. Should a hernia be found, it is to be dealt with appropriately. The testicles and cord, wrapped in boric gauze, are thrown up on the abdominal wall. The further steps of the operation consist in uniting the incisions made over the penis and cord by a transverse incision on each side, and then by a bold sweep of the knife (a large amputation-knife) removing the mass, cutting from the incision over the right cord carrying the knife low down between the scrotum and perineum, and then upward round the left side of the tumor until the incision over the left cord is reached. A few strokes will free the connections, and the tumor is received into the hands of the assistant. The compression of the tourniquet now being withdrawn, the hemorrhage that ensues is at times terrific, but not by any means uncontrollable. Vessels are seized and tied or twisted, and attention is directed to the condition of the margins of the wound. If they are diseased, as proved by their induration, they may be cut off. The state of the testicles is now examined, and if fairly healthy they are to be allowed to remain, but if hopelessly diseased they must be removed. The parts should be wiped with a warm sponge and the complete arrest of hemorrhage ensured.

The subsequent steps merely consist in applying unirritating antiseptic dressings, as no attempt can, or need be, made to bring the

edges of the skin together. The testicles, if present, are placed on the front of the perineum, the penis wrapped in wet boric lint, or in strips of lint soaked in carbolic oil, or dusted over with boric and starch-powder, iodoform, or some such antiseptic. The perineal wound is similarly treated, and the surface supported by protective antiseptic wool, gauze, or tow; a T-bandage, with a slit for allowing of urination, is applied to support the dressing, and the patient is removed to his bed. Dressings are to be subsequently applied according as the case proceeds.

The results of this operation are surprisingly good, an average of 95 per cent. of cases operated upon recovering. The parts cicatrize in a way that is astonishing. The penis is covered and the testicles are enclosed by a cicatricial tissue, which acts as a good pocket for their bestowal. Unless the testicles have been removed or are wholly atro-phied, sexual power remains; and the writer's patient, from whom he removed a weight of 49 pounds and left but one testicle, subsequently became the father of a child. The after-history of such cases has not been satisfactorily reported. That the disease does return in a few cases is known; but it is also known that for many years afterward cases have remained free from recurrence.

Sequelæ of Filarial Disease.—There are several sequelæ and concomitants of filariæ which call for surgical interference.

Retention of urine during an attack of chylous urine is not an uncommon condition. If by percussion the bladder is found to be full, or if the patient is distressed, a full-sized catheter ought to be passed. When clots of coagulated albuminous material clog the channel of the instrument a gentle stream of warm boric solution will free the passage and aid in the breaking up of the clot.

Filarial orchitis is by no means a common ailment; but it is just possible, as suggested by Manson, that the "malarial orchitis" of some French authors may prove on closer investigation to be filarial rather. The *treatment* is the same as that of orchitis from other causes.

Tumors of the lymphatic nature peculiar to filarial infection are met with in almost any part of the body. The mammæ may be the seat of the disease; and huge, dependent benign enlargement of the breast may result. The breast is to be supported, relieved, or removed according as the conditions require. Here and there on the limbs or trunk, and on the vulva, tumors of a filario-elephantoid nature occur. The tumor of the vulva at times attains an enormous size, and at first sight seems as though it were certainly a pendulous scrotum, and not a vulva, with which the surgeon has to deal.

FILARIA MEDINENSIS (Guinea-worm).

In several tropical countries there is found deeply embedded in the connective tissues of the human body, but more especially in those of the lower extremities, a long, delicate worm. The countries in which this disease occurs are Central India, Persia, Turkestan, Arabia, Central and West Africa, and in a limited area of Brazil. The disease is more prevalent during certain seasons than others, and in some localities, as on the West African coast, almost every native suffers. The worm, of

which only the female is known, is from 1 to $3\frac{1}{2}$ feet long, and about $\frac{1}{10}$ inch in diameter. Although usually met with in the legs, it may be found in any part of the body—head, arms, scrotum, etc.

The presence of the worm is made known by the development of a small ulcer, at the bottom of which is to be seen an opening leading down to a recess which contains the worm. At the fistulous opening a close examination will show a filiform-looking body, which is in fact the tail of the animal. If the part is well soaked with water, the protruded piece of the worm will swell up rather suddenly, and will be seen to burst, the fluid-looking contents, on examination by the microscope, revealing a mass of embryos. Each embryo measures about $\frac{1}{30}$ inch in length, and $\frac{1}{1000}$ inch in breadth. The microscopical field displays an enormous number of small worms coiled like a watch-spring or partly unfolded like a comma. Active movements characterize them, and their power of attacking the cyclops can be readily demonstrated. The fresh-water cyclops is the small crustacean which Fedschenko, while resident in Turkestan, found to be the intermediary host in which the parasite developed. It is inferred from this observation that it is through the ingestion of water that the guinea-worm gains access to the human body.

Treatment.—The old-fashioned plan of seizing upon the protruding part of the worm and entangling it in a piece of wood that was twisted day by day, so as to draw the worm from the wound, is not a good method. The delicate animal frequently breaks under the treatment, and, in consequence, the parts around become injected with, and inflamed by, the infiltrating embryos. Instead of this plan, several others have been devised. What might be termed the physiological, is that by keeping the part well soaked with water the female is thereby encouraged to go on shedding her embryos, until, after some fourteen days, she becomes exhausted, and can then be dragged from the wound with but little difficulty. Another, the therapeutic plan, is to inject, as recommended by M. Emily, the protruding part of the worm with a 1 : 1000 solution of mercuric chlorid. Then, thirdly, there is the surgical plan of cutting down to and evicting the worm.

TROPICAL ABSCESS OF THE LIVER.

In tropical practice no disease requires of the medical practitioner more skill in diagnosis and treatment than does abscess of the liver. The inception of the malady is so insidious, the existence of pus at times so obscure, that it is only by careful study and long experience that the practitioner can become either capable of diagnosing or of treating the condition.

Inflamed Liver.—Inflammatory and congested states of the liver are a daily experience in the tropics; yet, with all due attention and acumen, pus in the liver at times escapes the most able practitioners.

Treatment of Inflamed Liver.—Inflammation of the liver can be, and frequently is, relieved by surgical treatment. When counterirritation applied externally, draining of the liver by inducing purgation, and relief of the portal system by drugs, baths, wet packs, etc., fail to afford relief, great good is obtained by bloodletting. The blood should

be withdrawn from the organ itself by the aspirator, by the use of which hepatitis is often readily subdued. There is no difficulty and but little danger in hepatic aspiration, its application being extremely simple. In most cases a general anesthetic is unnecessary; local anesthesia by salt and ice, by a freezing spray, or by cocain, will allay the pain of the skin-puncture, and after the skin is traversed there is but little pain. Sometimes, however, acute pain is induced in the right shoulder during the deep passage of the needle. This pain seems to occur when the needle traverses the diaphragm, and it is but natural to suppose that a wound of a large branch of the right phrenic nerve is the occasion of the coincidence. Before inserting the needle of the aspirator a small incision in the skin is made by the knife. The needles of the aspirators in common use are usually too short for tropical work. In hepatitis the liver is greatly increased in bulk, and as the large-sized branches of either the hepatic or portal vein are therefore deeply seated, the needle must be at least 6 inches long. A needle 8 inches in length ought to be supplied with every aspirator made for use in the tropics, as at times a needle short of that will not reach the seat of an abscess if approached from the right lower costal region. The needle used for hepatic phlebotomy should be 6 inches long and of the widest size made.

The initial puncture is best made in the axillary line, between the sixth and seventh or the seventh and eighth ribs; or anywhere in the lateral lower right costal region where hepatic dulness is pronounced. When phlebotomy pure and simple is intended, the needle ought to be driven up to the hilt, the tap connecting it with the exhauster opened, and the needle slowly withdrawn. Should a fair-sized vein have been traversed, blood will flow freely from the needle when the point lies in the channel of the vein. When the quantity of blood advisable to be withdrawn is obtained the needle is pulled out, the wound covered with a small, thin pad of cotton-wool soaked in collodion, and a firm roller-bandage applied round the costo-abdominal region. It is best to begin to bandage from below upward, covering the body from immediately above the umbilicus to just below the nipples.

Should little or no blood escape when the needle is first introduced, it may be partially withdrawn and again pushed home, taking a direction more backward. If disappointed again, the same manipulation is to be repeated, but the point is to be made to travel more forward. Should blood still refuse to flow, the needle may be completely withdrawn and reintroduced either farther forward or farther back, according as the hepatic dulness indicates. As many as half-a-dozen punctures may be safely made in the search after blood (or pus: *see below*). Practically, the dangers attending this operation are nil. The punctures of the lung, pleura, and diaphragm have never been known to give rise to untoward symptoms, and the escape of blood into the peritoneum is harmless.

That blood does actually flow from the puncture in a congested liver the writer has had the opportunity of proving. While tapping an ascitic abdomen by the ordinary method with a trocar and cannula introduced between the umbilicus and pubes, the writer plunged the needle of an aspirator into the enlarged liver. In a few minutes, after a good many ounces of blood were obtained, the needle was withdrawn, and as the ascitic fluid continued to flow through the cannula the straw-colored fluid became tinged with blood. Toward

the end of the ascitic flow the fluid became very deeply tinged with blood, proving that the punctures in the liver were bleeding freely. No doubt when the wounds were closed blood escaped for some time into the emptied peritoneal cavity. The patient, it may be mentioned, made an excellent recovery, and it is interesting to know that after seven tappings—extending over eighteen months—the patient (a Chinaman) entirely recovered.

Abscess of the Liver.—The seat and etiology of liver-abscess affect the prognosis as to the beneficial effects of operation. Abscesses may be suprahepatic, intrahepatic, and subhepatic; and, in the opinion of the writer, the seat of the abscess has to do with the cause of the disease. The question of the association of hepatic abscess and dysentery is a vexed one; and most medical men try to induce patients suffering from hepatic abscess to confess to a previous dysenteric attack. This, however, is not in many cases successful. Whether dysentery be an antecedent, a concomitant, or a sequela of liver-abscess is a question in dispute, many believing that the dysentery is induced by the hepatic state. In the writer's belief intrahepatic abscess is frequently—in fact, generally—a sequela of dysentery, or, at any rate, intimately associated with it. Suprahepatic abscesses, wrongly classed with subdiaphragmatic abscesses, on the other hand, may, and in fact do, develop independently of dysentery altogether. To make this clear, the writer's opinion as to suprahepatic abscess will be first stated.

Suprahepatic Abscess (*Abscess of the Dome of the Liver; Abscess at the Back of the Liver*).—In the region between the liver and the diaphragm there is often encountered a collection of pus.

Of 27 cases of abscess of the "liver" that came within the writer's notice and treatment, 20 were suprahepatic; the remaining 7 being classed as intrahepatic (or 6 intrahepatic and 1 subhepatic). The verification of the position of several of these abscesses was obtained at post-mortem examination; and the fact of pus on the dome of the liver being a separate disease established by clinical and pathological evidence.

Anatomical and Pathological Characters.—In a post-mortem examination upon a case of suprahepatic abscess of the liver, it may be seen after opening the abdomen that the liver is perfectly natural in size, shape, color, and consistence. On examination of the right chest and pleura the costal and visceral pleural layers may be smooth, glistening, and normal. No sign of pus or inflammatory change is to be seen, and it would seem as though the abscess had healed, and that some other disease had caused death. By closer examination of the lung it will be found that it cannot be raised from the diaphragm, and on turning to the hepatic region it will be found that the coronary ligament of the liver appears to bulge abnormally. Here, within the folds of the coronary ligament, is the seat of the disease, the boundaries of the locality are *above* the diaphragm, *below* the piece of the liver destitute of peritoneum, and *circumferentially* the peritoneum passing between the liver and diaphragm forming the coronary or suspensory ligament. The pus may have mostly escaped through an opening in the diaphragm above, have burrowed through the lung, and found its way toward and into a bronchus. The liver-surface will be seen to be scooped out to a variable depth, the maximum being ¾ inch, and the exposed surface covered with inflammatory material. The peritoneum around will be seen to be thickened in the usual way.

The inferior vena cava and the right suprarenal capsule are not involved. It is in the lymphatics that the inflammation commences, and the lymphangitis induced goes on to suppuration. We know from the researches of Vaughan Harley the connection between the liver-functions and the thoracic duct. Harley has shown that when the ductus communis choledochus is ligatured jaundice ensues; but that when in the same subject the thoracic duct is ligatured jaundice fails to appear. This experiment proves that the coloring and other matters of the bile gain entrance to the blood by the thoracic duct; and to gain the thoracic duct they must escape from the liver by the lymphatics. The writer contends that when the liver is subjected to sudden chill, causing congestion, hyperemia, and, it may be, inflammation, the lymphatics become inflamed, blocked, and break down, causing a suprahepatic abscess. The pus from such an abscess is usually sterile.

It will thus be seen that there is no preliminary dysentery required to account for the disease, and it is well-nigh impossible to understand how dysenteric infection, fluid or embolic, could primarily affect the lymphatics *leaving* the liver.

The chief cause of the ailment is chill. Just as in temperate regions exposure gives rise to chest troubles, bronchitis, pleurisy, and pneumonia, so in tropical countries the liver is attacked, causing hepatitis, perihepatitis, or suprahepatitis.

Signs and Symptoms.—The symptoms of suprahepatic abscess are a sudden pain in the right lower costal region, deeper seated than pleuritic pain and less sharp. There is difficulty, or rather dread, in breathing, and fever (102° or 103° F.), with its usual accompaniment of nausea, headache, backache, foul tongue, dry skin, and hard pulse.

By rest in bed and appropriate treatment the acute symptoms may subside, admitting of more careful examination of the chest. On percussing out the liver it will be found that the lower border does not advance appreciably below the normal level. The surface of the liver itself shows but little tenderness to percussion; but when the liver is grasped by one hand over the right lumbar region, and the other in the epigastrium, a sharp pain shooting up to the acromioclavicular angle is elicited. Percussion along the upper border of the liver, however, betrays the nature of the disturbance. Here there will be found an abnormal area of dulness extending upward and encroaching on the right lung. In the early stages the dulness is in the axillary line; but as the disease advances, and more especially in the later stages, when pus has formed in some quantity, the dull area is met with more in the nipple-line or even internal to it. The shape of the swelling alters. In the early stages it is round and more diffuse; later it assumes an almost conical shape, with its apex upward and the base continued into the general mass of the liver. At times the swelling can be readily discerned, the lung-tissue around being normal as regards resonance and vocal fremitus. But the condition of the lung varies from day to day, almost from hour to hour, and the area of dulness may at consecutive examinations puzzle the surgeon. When the increased area of dulness is present, the surgeon may assume that operative measures must be forthwith undertaken; but if some hours intervene before the next examination preliminary to operating, he may, in deference to the clearing up of the lung, be induced to postpone operation. So pronounced may be the improvement in the condition of the lung that it would seem as though the whole trouble was about to resolve. This, however, usually proves illusory, and sooner or later the patient suddenly coughs up a quantity of pus. This may be a fortunate ending to a train of symptoms, but it is a condition for which no surgeon is justified in waiting. When the suspicion of pus is present no delay is warranted, and the symptoms of temporary clearing up of the lung-condensation are delusive. As exploration of the liver by aspiration is preliminary to dealing with the pus, there need not be any hesitation in advancing the diagnosis by employing this harmless procedure. It is necessary to have all the instruments ready in case pus is found. If no pus is found, whether it is actually there or not, good only can result to the inflammation from the needle-punctures.

Operations.—The treatment of liver-abscess will be considered under two groups, the method by trocar and cannula, and the method by incision.

A. Operation by the Trocar and Cannula.—This method, on account of its simplicity and the chances of recovery it affords the patient, is eminently satisfactory. If deep-seated abscesses are to be reached, the trocar and cannula is most efficient, and with this instrument the surgeon will be induced to operate at a much earlier stage than if the knife is to be relied upon. Given pus between the liver and diaphragm, situated some 4 or 5 inches from the surface, to reach the pus by a cutting operation is a task few practitioners care to undertake at an early stage of the disease. Of course, if the abscess has been neglected and allowed to run its course, and to bulge or point either in the costal region or toward the abdominal wall in front, an incision may be, and no doubt is, effectual; but deep-seated abscess of the liver —and few are not so in their initiation—should not be thus treated.

Operation.—After administering an anesthetic the aspirating-needle is introduced in the same way and with the same precautions as in hepatitis (see above). Should pus flow through the needle, it must be immediately withdrawn, as it is not desirable to empty the abscess-cavity. Having by this manipulation settled the position and depth of the pus, the further steps are as follows: With a large trocar and cannula, measuring in length from tip to handle-root 6 inches, and in diameter not less than $\frac{3}{8}$ inch, puncture the side, entering at the same point and pursuing the same track as that followed by the pioneer needle. The depth to be gained will be gauged by the depth at which the aspirator-needle reached pus. When the trocar has penetrated the prescribed area withdraw the trocar, and when pus appears close the orifice of the cannula by placing the thumb over it, so as to retain the pus until the tube is introduced. The next step is to introduce an India-rubber tube of a large size—larger than the caliber of the cannula. To effect this the probe here described is passed along the tube and made to catch into a slit near its end. The probe is a stout piece of steel, 1 foot long, measured off in inches, and with blunt ends. Close behind one end of the rod is a short, curved steel spine, which, when the rod is passed along the lumen of the tube, catches the side of the tubing and allows the tube to be drawn tightly, so that when it is so attenuated it can be introduced along the cannula. The writer had this steel rod manufactured by Montague, of New Bond Street, London. The tubing is not less than $\frac{1}{2}$ inch in diameter, and 8 inches long, with apertures cut near the end to allow of the ready entrance of pus. With the tube stretched tightly over the probe it is reduced to a size that renders it capable of being passed along the cannula. When the end of the probe bearing the tube reaches the bottom of the track—that is, the abscess-cavity—it is held there, and the cannula withdrawn completely, slipping it over the tubing. When the cannula has emerged completely the tube is allowed to slacken and the probe is withdrawn. We have then a wide tube leading to the bottom of the cavity, and by its bulk completely blocking up the skin-aperture and the various tissues traversed by it. The piece of drainage-tube projecting from the side is now cut off to within one or two inches of the skin, a

piece of thread passed through it in case of accident, and the whole covered over by a large mass of absorbent wool, secured by a light bandage or, better still, by strapping.

If favorable symptoms continue the tube is gradually withdrawn day by day, until, when the discharge ceases, it is completely removed. A smaller tube may be substituted if the track is not quite closed.

The results of this operation are most satisfactory. Four cases thus treated by Mitchell Cowie in Hong Kong all recovered; 3 cases treated by Inspector-General Alexander Turnbull, R. N., at the Naval Hospital, Hong Kong, all recovered; and of 21 cases treated by the writer, 17 recovered and 4 died. The operation here recommended is a modification of the plan of treatment followed by Manson, and shown to the writer in Hong Kong. It will be observed that no washing out of the cavity is recommended. The only cases in which the writer followed that plan resulted in death, although, in the hands of other operators, it seems to have done good. It may be at once stated, however, that for suprahepatic abscess it is an unnecessary and an unwise proceeding. If the diaphragm is intact there will be a tendency to compress the cavity and to squeeze out the pus, as it were, from between the diaphragm and liver. It is quite possible, however, washing might do good in large intrahepatic abscesses.

The length of time a tube may be worn is indefinite. As long as discharge comes it should be retained. It gives rise to no inconvenience.

One patient operated upon by the writer went through the Chino-Japanese campaign as a war correspondent with the tube in his side, and it was only when the war was over that he finally withdrew the tube.

Suprahepatic abscess may be multiple, as may intrahepatic lesions. It is less frequently so; but the writer has seen post-mortem evidence of one or two small unruptured abscesses between the layers of the broad ligament alongside of an abscess that had been tapped and drained. The cause of death after tapping and draining a suprahepatic abscess is probably the formation of another alongside. If, after successfully reaching and draining an abscess, the symptoms do not rapidly improve, suspicions ought to be roused that another abscess is present. In such circumstances it must be promptly found and drained.

Intrahepatic Abscess.—An abscess in the substance of the liver may be, and often is, associated with dysentery, and may form some time after the attack of dysentery has ceased. The connection between the two diseases is accounted for by the absorption of infective products from the surface of the intestine, which, gathered by the radicles of the portal vein, are caught in the branches of that vein in the liver. If this etiology be the true one, it is not surprising that multiple abscesses are present. Although ulcers of the intestine from other causes—typhoid, tubercular, cancerous, etc.—are rarely followed by abscess of the liver, it must be remembered that dysenteric inflammation of the intestine is of a totally different nature to that met with in other diseases. The attack is rapid in its onset, violent, and associated with gangrenous and degenerative processes little calculated to obliterate the veins, but rather to leave them open and ready to transmit infective fluids and particles.

A hepatic abscess may attain enormous size. One half of the liver may be converted into a bag of pus, while the other half remains healthy and carries on the work of the economy. Hepatic abscesses may be, on the other hand, numerous, although one frequently predominates and develops, while the others remain in abeyance.

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The Course of Pus.—Suprahepatic abscesses always tend to travel upward toward the chest; but intrahepatic abscesses may burst into the stomach, duodenum, colon, the peritoneal cavity, or the cavity of the pleura; they may perforate the lung and reach a bronchus, or advance and reach the abdominal wall. It is when the last direction is taken that surgical interference is pronouncedly called for. An abscess pushing forward toward the anterior abdominal wall causes inflammation of the peritoneum on the liver and on the parietal patch opposite. At first perihepatic friction can be felt or heard; but as the peritonitis advances the two surfaces become bound together, and on auscultation it will be found that in the center of the area no friction-sounds are to be heard, but in a circle around they are distinctly present. This condition of parts guides the operator where to cut or puncture, namely, in the center of the dull patch, where the peritoneal surfaces are firmly adherent, and where a path is formed for the pus to reach the surface. The operation requires but little skill, and is very different in its inception and manipulation from that required in abscesses which protrude toward the back of the liver. When, however, the abscess bulges at an intercostal space, it may be freely cut down upon or the pus drawn off by a trocar and cannula, and a drainage-tube inserted.

Some operators recommend removal of a piece of rib in almost all liver-abscesses bulging laterally, a wholly unjustifiable step, unless the abscess-cavity is enormous and the delay in operation has allowed the pus to push up and absorb the diaphragm, thereby attaining the nature of an empyema rather than a hepatic abscess.

Delay in operation has the most fatal consequences in all abscesses in the hepatic area. Careful examination of the liver by percussion and auscultation, combined with the general symptoms and signs when they suggest the possibility of pus, ought to lead to exploratory punctures. To allow an abscess to attain the dimensions and position of an empyema, to occupy a large area of the liver, to advance and point anywhere upon the wall of the abdomen, is unjustifiable. The notion that it is safe to allow the pus to determine its own course and exit is pernicious.

If the abscess-cavity is large, if the chest-wall for some distance forms part of the boundary, a counteropening is advisable. If the pus in an abscess of such dimensions and adhesions is foul, the cavity may be washed out with a disinfecting lotion. Perhaps creolin (1 : 600) is the best for the purpose. With a counteropening there is not the same danger in washing out the cavity as when only one opening leads to the abscess.

B. Operation by Incision.—I. In the Abdominal Wall.—(a) When Adhesions have Occurred.—Into the area at which pus in the liver has been diagnosed an aspirator-needle is thrust; and while the cannula is left in position as a guide, an incision some 3 inches long is made in the abdominal wall. When the parietes is fully incised, and firm adhesions are seen to obtain, a sinus-forceps is pushed along the cannula into the abscess-cavity. The needle is now withdrawn and the blades of the forceps expanded. Through the aperture thus made the forefinger is introduced and the abscess-cavity examined. A large-

sized drainage-tube of a suitable length and some ¾ inch in diameter is inserted, and when the abscess-cavity is fairly well drained of pus an antiseptic dressing is applied.

It may be said about this operation that, for the sake of the patient, liver-abscesses should not be allowed to reach such a stage. That pus should be allowed to collect in the liver in sufficient quantity to destroy the tissue, until such time as the wall adheres to the parietes of the abdomen, can be explained either by the patient having come for treatment at a late period (a thing not at all likely), or that the practitioner has failed to diagnose the disease. When such is the case, then the operation described above is, of course, necessary. What good, however, can come of disturbing the friable and tender wall of the abscess by introducing the finger, or what better chance the patient has by the information so gained, one fails to see.

(*b*) *When no adhesions have taken place between the liver and the abdominal parietes, or when such adhesions are unreliable*, the surface of the liver is to be stitched to the margins of the abdominal wound by a double row of sutures. The parts around may then be protected by packing with antiseptic gauze and opened immediately; or the wound covered with an antiseptic dressing and the pus-cavity cut into a day or two later.

There are various difficulties with which to contend in this proceeding. In the first place, it is very difficult to get stitches to hold in an inflamed liver. The material is very friable at best, but much more so when it is inflamed and on the point of breaking down before the advancing pus beneath. Moreover, if the pus is near the surface of the liver, which in nine cases out of ten it is, there is a great chance of the needle used in applying the suture penetrating the abscess-cavity and allowing the pus to escape.

II. In the Chest-wall.—When the aspirator-needle inserted through the chest-wall proclaims pus to be present, the steps adopted by some surgeons are as follows: An incision of sufficient size—some 4 inches in length—is made in the skin adjacent to the spot punctured by the needle. If it is evident that the ribs encroach on the intercostal space so as to interfere with the subsequent manipulations, 2 inches or more of the obstructing rib must be excised. The diaphragm is then to be stitched to the (skin) margins of the wound, and a forceps thrust through the diaphragm and expanded. When an aperture is made in the diaphragm sufficiently large to gain sight of the liver, the two are stitched together. The abscess-cavity is then opened and a drainage-tube pushed into the cavity. When empty, suitable dressings are applied and renewed as often as occasion requires. One point of great consequence in this operation is the danger run in opening the pleura. When such an untoward event occurs pneumothorax will ensue or pus will find its way in the pleural cavity. To obviate such catastrophy, it is necessary to sew up the pleural wound before any farther step is taken. About this operation the only remark to be made is that when the pus is absolutely bulging at an intercostal space, it is no doubt within the sphere of rational surgery; but with a deep-seated abscess the sooner such an operation is held to be obsolete, the better.

Neil MacLeod, of Shanghai, uses a metal drainage-tube which has

some advantages.   He condemns excision of a part of a rib as unnec-
essary, and declares it inexpedient to attempt to stitch the liver to the
coverings.

In dealing with liver-abscesses the writer has successfully employed
the plan shown him by Manson—namely, by the trocar and cannula—
and he has seen it used in the hands of others with even better results.
(See the cases of Cowie and Inspector-General Turnbull mentioned
above.)   The writer's method differs from that of Manson's in being
more simple and easy of performance ; but in principle it is Manson's
plan which he has followed, and with pronounced success.   The ques-
tion resolves itself into this : If the patient is left until pus bulges at
either the abdominal or intercostal walls, there need be no hesitation
of putting a knife into the abscess more than in any other part of the
body; but no practitioner is justified in allowing a liver-abscess to
reach that stage.   Aspiration is not only easily performed, but is so
directly beneficial to the inflamed liver that there need be no hesitation
in even the first days of threatening abscess so to act.   When pus is
found, say 5 inches from the surface, more especially when the needle
has entered by an intercostal space, then the trocar and cannula is the
only rational method of treatment.

MYCETOMA ; MADURA FOOT ; THE FUNGUS FOOT OF INDIA.

The disease indicated by the above names is usually spoken of as
" Madura foot."   Madura is a large city in Southern India, in the dis-
trict around which the disease is most prevalent.   The disease also
prevails in several parts of India, however, more especially in the dis-
trict north from Bombay, between the valleys of the Indus and the
Ganges, and again in Kashmere.   If report be true, it is not confined
to India, for it exists in the French provinces of Indo-China.   But
even in Europe cases have been described which, according to the
Italian observers, exactly resemble Madura foot.   Nor are the conti-
nents of Africa and America exempt, for we have accounts of myceto-
matous disease from Algeria and from both North and South America.

(For the pathology of this affection see Vol. I., Chapter VII.)

Surgical treatment is usually confined to amputation of the dis-
eased part.

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